RADIOLOGY

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RADIOLOGY

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Cerebral Angiography in Agenesis of the Corpus Callosum[1]

COLIN B. HOLMAN, M.D., and COLLIN S. MacCARTY, M.D.

AGENESIS of the corpus callosum is an interesting and rather uncommon error in the development of the brain. According to Davidoff and Epstein (1), it was first described by Reil in 1812, and 83 cases of partial or complete agenesis of the corpus callosum found at necropsy had been recorded prior to 1934. These writers credited Guttman with the first description of the pneumoencephalographic changes in 1929, although the diagnosis in that particular case was made at necropsy. Davidoff and Dyke (2), in 1934, reported 3 cases, 2 of which were recognized by their pneumoencephalographic characteristics; the lesion in one of these was subsequently proved by operation.

At the present time, although the features of complete or relatively complete agenesis of the corpus callosum are well known, little has been written concerning the changes demonstrated by cerebral angiography. Because of the frequency of cerebral angiographic examinations now being carried out on patients who show rather nonspecific clinical syndromes, it is important that these roentgenologic features be recognized. Although the condition is rather rare, it is probably more common than the number of reported cases would indicate, and thus one might expect to see evidence of it in cerebral angiograms more commonly than has been true in the past.

PNEUMOENCEPHALOGRAPHIC FEATURES

Hankinson and Amador (3) recently published a rather complete treatise on the pneumoencephalographic characteristics of agenesis of the corpus callosum. They collected data in 24 such cases previously reported in the literature and added 14 examples of their own. These authors are in agreement with us that the condition is probably more common than the number of reported cases would indicate. Seventeen cases were diagnosed at the Mayo Clinic between 1948 and 1957, while the 2 instances to be reported here were seen during a three-week period in 1958. Since the pneumoencephalographic features are well described in Hankinson and Amador's excellent review, we shall not detail them here except to list the common diagnostic criteria in order to afford a better understanding of the angiographic appearance.

The characteristic changes in the pneumoencephalogram as indicated by Hankinson and Amador are (*1*) pronounced separation of the lateral ventricles, (*2*) angular dorsal margins of the lateral ventricles, (*3*) concave medial borders of the lateral ventricles, (*4*) dilatation of the caudal portion of the lateral ventricles, (*5*) elongation of the interventricular

[1] From the Mayo Clinic and Mayo Foundation (C. B. H., Section of Roentgenology; C. S. MacC., Section of Neurologic Surgery), Rochester, Minn. The Mayo Foundation is a part of the Graduate School of the University of Minnesota. Accepted for publication in June 1958.

foramina, (*6*) dorsal extension and dilatation of the third ventricle, (*7*) radial arrangement of the medial cerebral sulci around the roof of the third ventricle and their extension through the zone usually occupied by the corpus callosum, and (*8*) a large cisterna magna. These criteria were first described by Davidoff and Dyke (2). They may not all be present in any individual case.

ANGIOGRAPHIC FEATURES

The angiographic appearance of this interesting condition was first described in detail by Sheldon and Peyman (4) in 1953. These authors reported 2 cases, the second of which was diagnosed correctly prior to pneumoencephalography. They pointed out that the ascending portions of the anterior cerebral arteries ran almost directly upward and then turned rather sharply posteriorly, at a much lower level than under normal conditions, while the usual curve of the artery as it turns around the rostrum of the corpus callosum was absent. For the remainder of its course the pericallosal artery extended immediately above the roof of the third ventricle. The internal cerebral vein was said to occupy a higher level than usual, also above the roof of the elevated third ventricle. The normal curve of the great cerebral vein was greatly diminished and was situated above and in front of its usual position.

One of Sheldon and Peyman's patients was a twenty-eight-year-old man with a history of "fits" since the age of ten years. The diagnosis of agenesis of the corpus callosum was obvious at pneumoencephalographic examination. Cerebral angiography was then done and the characteristic changes described above were noted. The second patient was a twenty-four-year-old man who gave a history of seizures for five years. Cerebral angiography in this instance was undertaken as a primary diagnostic procedure. The condition was recognized and was proved by subsequent pneumoencephalography.

In 1940, Mäurer (5) reported a case of agenesis of the corpus callosum in the German literature, with a description and illustrations of the angiographic appearance. The lesion in this case was first diagnosed by pneumoencephalography. In 1952, Zellweger (6) reported in the Swiss literature an account of 7 cases of agenesis of the corpus callosum. He described and demonstrated the cerebral angiographic characteristics in 5 of these. All of the angiograms, however, were made following diagnosis by pneumoencephalography. Thus, as far as we have been able to determine, the 2 cases now being reported are the only instances recorded, other than the case described by Sheldon and Peyman, in which identification of this lesion was made by cerebral angiography prior to pneumoencephalography.

REPORT OF CASES

CASE I: A 19-year-old boy came to the Mayo Clinic in March 1958, with a history of several dizzy spells associated with unconsciousness. Between June 1956 and March 1958, he experienced ten or twelve such episodes occurring in the evening or during the night. Throughout his life he had been mentally dull, as judged by his father. He had been unable to finish the eighth grade in school and was a disciplinary problem at home. Because of symptoms involving his left arm and leg, a right carotid angiogram was obtained in a search for a possible arteriovenous anomaly involving the right side of the brain.

In the anteroposterior half-axial view, the ascending portions of the anterior cerebral complex on either side arose in the midline in the usual manner (Fig. 1, *a*). Slight separation of the left and right anterior cerebral arteries was noted at about the level usually occupied by the rostrum of the corpus callosum. The most striking abnormalities were noted on the lateral examination (Fig. 1, *b*). The courses of the main branches of the right middle cerebral artery were unaltered. The ascending branches of the anterior cerebral arteries rose abruptly superiorly, and there was reversal of the anterior curve of these vessels ordinarily seen in their course around the rostrum of the corpus callosum; the extensions of these vessels continued to rise superiorly. The vessels corresponding to the callosal marginal branches arose in the usual location and extended anteriorly and superiorly. The vessels coursing anterior to the ascending portion of the anterior cerebral arteries extended well into the frontal regions. No indication of a mass in the frontal portion of the brain was present. This also was confirmed by the position of the vessels in the anteroposterior half-axial view.

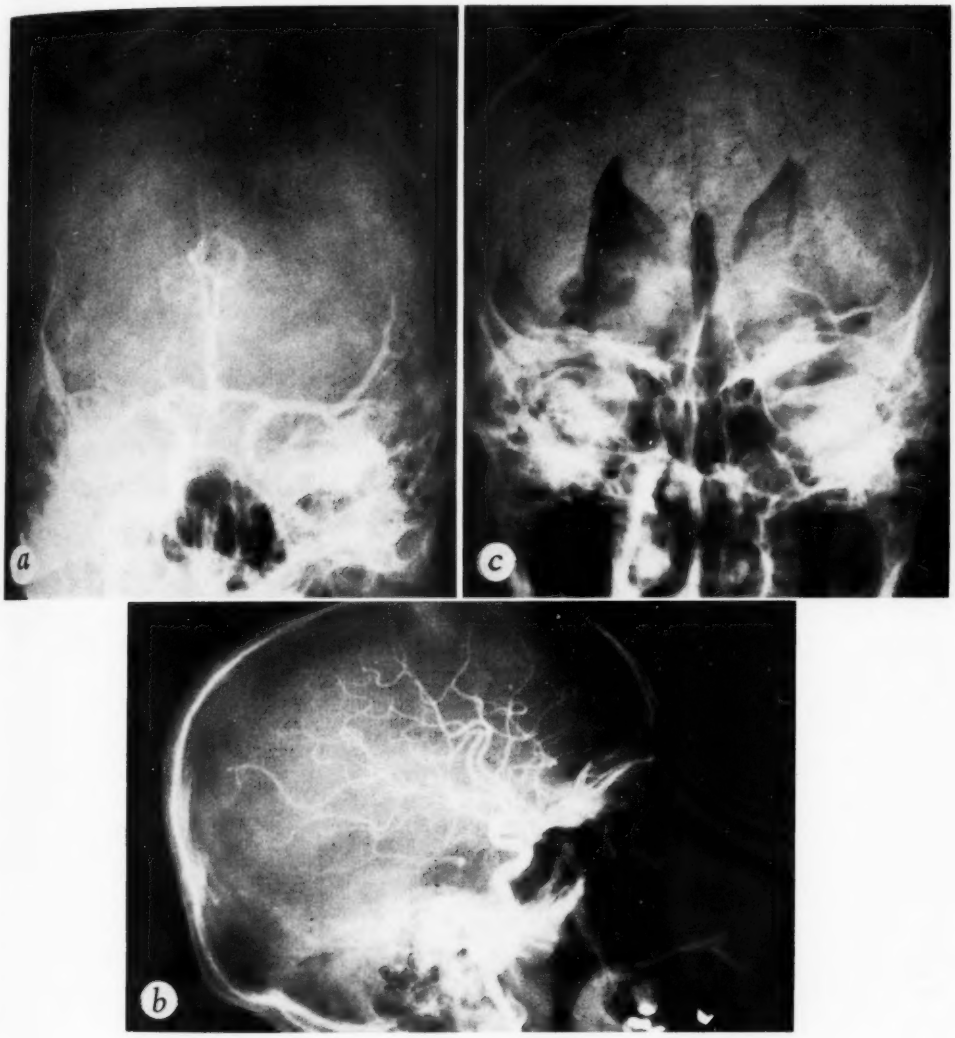
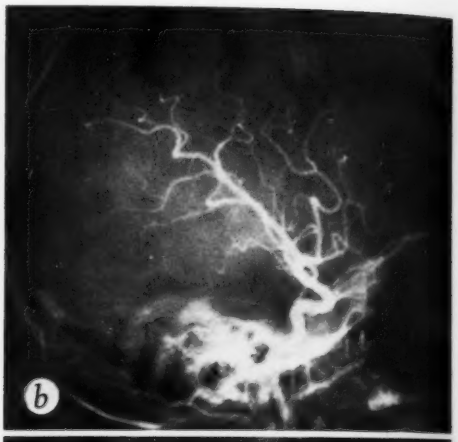


Fig. 1. Case I. (*a*) Anteroposterior half-axial right internal carotid angiogram. See text for details. *b*. Lateral right internal carotid angiogram. See text for details. *c*. Anteroposterior pneumoencephalogram. Typical appearance of agenesis of the corpus callosum.

The venogram showed the venous angle to be somewhat posterior and above its usual location, but this change was not pronounced. Little, if any, evidence of flattening of the curve of the great vein of Galen was noted, and disturbances of the basilar veins were absent. The inferior longitudinal sinus did not become opacified during this examination.

These changes in the cerebral angiogram were thought to be consistent with agenesis of the corpus callosum, and such a diagnosis was made. A confirmatory pneumoencephalogram was done on the following day, and the typical appearance of the ventricular system associated with this lesion was demonstrated (Fig. 1, *c*).

CASE II: A 10-year-old boy came to the Clinic in March 1958, for treatment of convulsive seizures experienced over the past three months. He had been treated for convergent strabismus for five years. Physical examination gave essentially normal results. Because the pattern of his convulsions suggested involvement of the left side of the brain, a left carotid angiogram was obtained to check for the presence of a possible arteriovenous malformation.



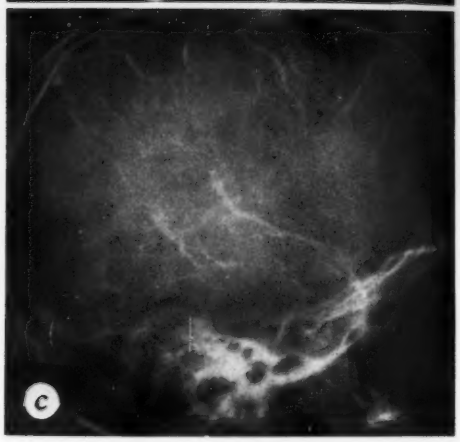


Fig. 2. Case II. *a*. Anteroposterior half-axial left common carotid angiogram. Note "wandering" character of branches of anterior cerebral artery. *b*. Lateral left common carotid angiogram (arterial phase). Note elevation of sylvian vessels and "wandering" course of anterior cerebral vessels. *c*. Lateral left common carotid angiogram (venous phase). Note slight elevation of left internal cerebral vein.

The anteroposterior half-axial view showed a "wandering" course of the ascending portion of the left anterior cerebral artery at about the level ordinarily occupied by the rostrum of the corpus callosum (Fig. 2, *a*). There was no actual dislocation of the vessel. The sylvian arteries appeared to be located a little higher than usual.

The left lateral arteriogram demonstrated an abrupt superior course of what ordinarily would represent the pericallosal branch of the left anterior cerebral artery through the usual location of the rostrum of the corpus callosum (Fig. 2, *b*). Above this location, the vessel turned forward and downward and then "wandered" backward and well upward. The vessel corresponding to the callosal marginal branch continued to course upward in a most uncharacteristic pattern.

The arteries of the sylvian group were located well above their usual course in a manner suggesting the presence of a posterior temporal mass, although there was no evidence in the anteroposterior half-axial projection of lateral dislocation of vessels to support such a diagnosis. The angiogram made in the venous phase showed the left internal cerebral vein to be located at a slightly higher level than usual, but no definite change was noted in the form or position of the great vein of Galen (Fig. 2, *c*).

These features were thought to be due to agenesis of the corpus callosum with either more pronounced dilatation of the posterior portion of the left lateral ventricle than is usually seen associated with this anomaly or actual porencephalic dilatation of this portion of the ventricle.

Two days later, pneumoencephalography demonstrated, in addition to agenesis of the corpus callosum, porencephalic dilatation of the posterior portion of the left lateral ventricle (Fig. 3).

COMMENT

The cerebral angiographic characteristics of agenesis of the corpus callosum should be well known to radiologists and neurosurgeons, particularly since cerebra

Fig. 3. Case II. *a*. Anteroposterior pneumoencephalogram typical of agenesis of the corpus callosum. *b*. Lateral pneumoencephalogram, left side up, showing pronounced dilatation of left lateral ventricle posteriorly and less dilatation of the posterior portion of the right lateral ventricle.

angiography is becoming a frequently used special examination in the study of patients presenting uncharacteristic neurologic syndromes or other evidence of possible congenital abnormalities involving the brain. These features appear to be sufficiently characteristic to warrant a diagnosis. Various degrees of agenesis may be present, and the condition is sometimes associated with other anomalies that can best be detected by pneumoencephalography. However, inasmuch as neurosurgical procedures ordinarily are not contemplated in the management of these patients, it would appear that the angiogram would suffice in some cases for all practical purposes. The limitations of any of these special procedures, however, are to be borne in mind.

SUMMARY

The cerebral angiographic manifestations in 2 cases of agenesis of the corpus callosum have been described. These represent the second and third reported instances in which the diagnosis has been made prior to pneumoencephalography, operation, or necropsy. The angiographic features appear to be sufficiently unique to make possible the establishment of this diagnosis.

The Mayo Clinic
Rochester, Minn.

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SUMMARIO IN INTERLINGUA

Angiographia Cerebral In Agenese Del Corpore Callose

Es describite le manifestationes cerebro-angiographic in duo casos de agenese del corpore callose in patientes de 10 et 19 annos de etate, respectivemente. Es opinate que il se tracta del secunde e del tertie caso a trovar in le litteratura in que le diagnose esseva facite primarimente per angiographia—ante le effectuation de pneumoencephalographia, operation, o necropsia. Le aspectos angiographic—consistente de cursos anormal del arterias antero-cerebral e de lor brancas ascendente—pare esser sufficientemente unic pro render possibile le establimento del diagnose.

Some Migratory Aspects of Inflammatory Collections of Pancreatic Origin[1]

MAXWELL H. POPPEL, M.D.

IN RECENT years roentgenologists have become increasingly aware of the continuing, chronic, relapsing, and progressive nature of pancreatitis, as well as its varied manifestations. Its presence may be difficult to detect, or even suspect, since the clinical picture and history may vary from patient to patient and even in the same patient at different times.

Accordingly, possibly because of some enzymatic activity of the inflammatory collection, more likely because of the favorable action of various anti-inflammatory agents attenuating the disease, and also because of better methods of roentgen diagnosis, we have in the past ten years observed more than 30 patients in whom inflammatory collections of pancreatic origin migrated to various regions in the abdomen or thorax.

In many instances, these inflammatory collections presented at a distance as the initial phase of the disease, masquerading as a local abscess, a perinephritic abscess, a subphrenic abscess, a fistula, a pleurisy, an empyema, a mediastinal mass, an appendicitis or a perityphlitis, an abscess in the left iliac fossa, a collection in the lesser sac, and a true cyst.

When the inflammation extends beyond the confines of the pancreas, there may be visualized localized space-occupying lesions labeled inflammatory tumefactions or collections. These may become located in the retroperitoneal area behind the pancreas, in the lesser omentum between the stomach and liver, in the lesser peritoneal sac, in the gastrocolic ligament between the stomach and the transverse colon, or high up under each half of the diaphragm. On the right side the collection may remain *in situ* between the liver and the diaphragm or perforate into the right pleural cavity, producing an empyema.

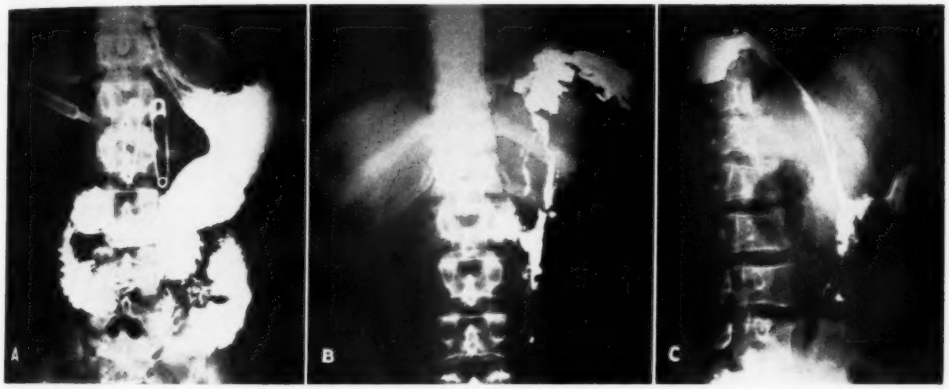

Fig. 1. A. A large inflammatory collection between the cardia of the stomach and the left diaphragm, following an acute pancreatitis. The esophagus is bowed medially.
B. Same case. Following the surgical drainage of the pancreatic area, there developed fistulas from the pancreas to the left subphrenic region and from the pancreas to the anterior abdominal wall. Opaque material injected through the opening on the anterior abdominal wall outlined the tract to the pancreas and the tract from the pancreas to the left subphrenic region.
C. Same case. Left lateral view.

[1] From the Department of Radiology of New York University College of Medicine and from the Radiological Service of Bellevue Hospital Center, New York, N. Y. Presented at the Forty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16–21, 1958.

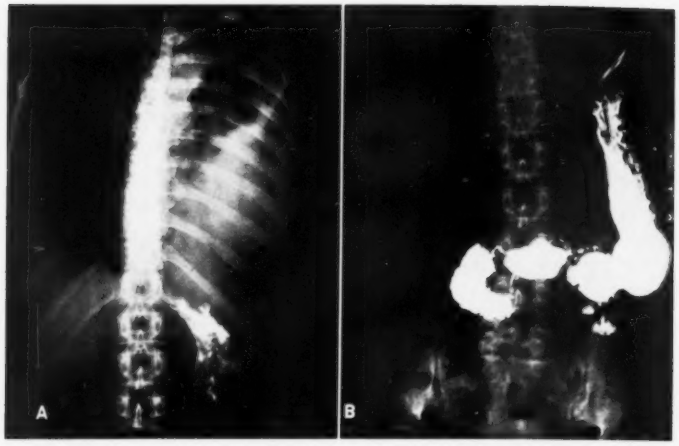

Fig. 2. A. Fluid seen in the left pleural cavity. The cardia of the stomach is depressed, but the esophagus is in its normal position.

B. Film obtained two weeks later shows a cluster of small pancreatic calcifications in the pancreatic tail. The esophagus is seen deviated far to the left. The inflammatory material worked its way up under the left diaphragm, through the diaphragm, into the left pleural cavity. The fluid obtained by aspiration from the left pleural cavity contained pancreatic enzymes.

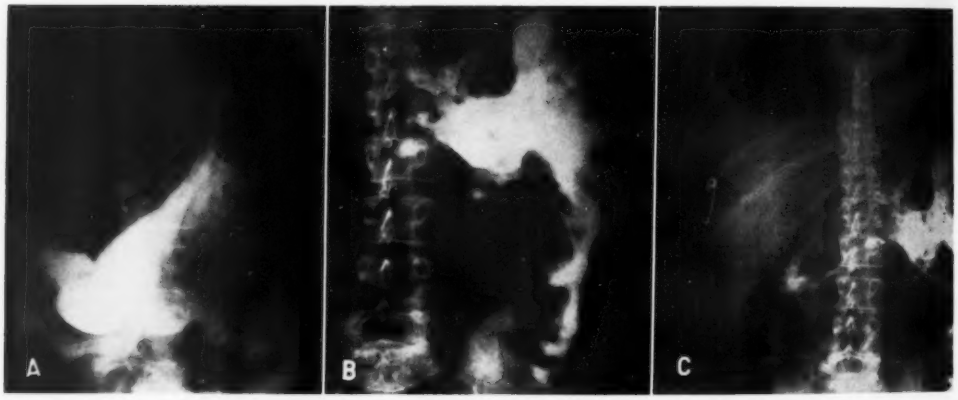

Fig. 3. A. An inflammatory collection between the stomach and the ligament of Treitz region. The mucosa of the stomach and the small bowel in this region is edematous.

B. After drainage and fistulography *via* the loin, there is visualized an extensive collection extending laterally upward and downward from the diaphragm to well below the iliac crest and medially toward the pancreas.

C. Operative pancreatography establishes a connection between the pancreatic duct and the medial end of the fistula.

Left subphrenic collections may also remain *in situ* or break through the diaphragm, forming mediastinal, pericardial, or pleural collections. In one such instance, there was lysis of the diaphragm and the esophagus deviated towards the left. In another, the inflammatory material lysed the diaphragm in the region of the esophageal orifice and drained upward into the mediastinum posteriorly as far as the level of D-4, forming a large pseudocyst which could be demonstrated by postoperative pancreatography. The inflammatory material may drain downward retroperitoneally to the right lower quadrant, producing a perityphlitis. On the left side the material may collect just beyond the pancreatic tail in the region of the hilus of the spleen or track down the left gutter retroperitoneally for variable

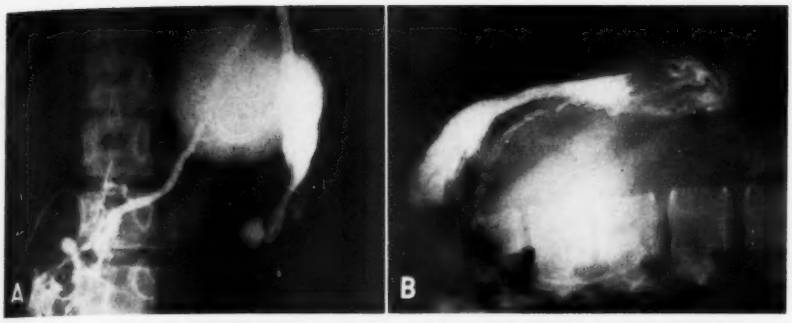

Fig. 4. A. Postoperative pancreatography opacifies a large collection in the region of the tail of the pancreas, with a downward tail-like projection.
B. Lateral view in the supine posture shows the stomach opacified with barium given by mouth. It is displaced forward and contains residual opaque material in the collection from the previous pancreatography.

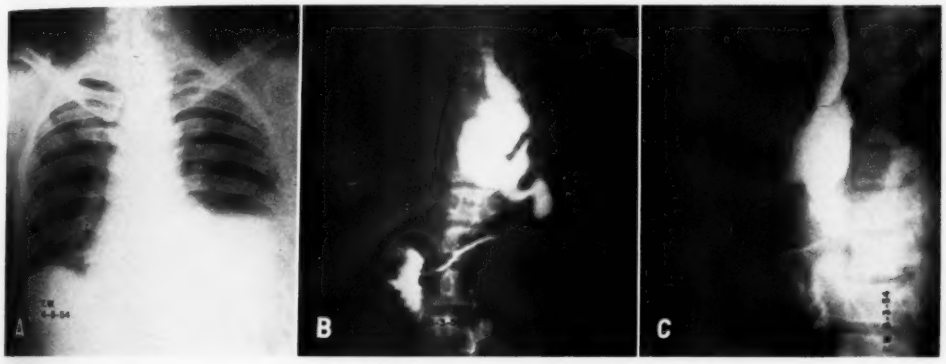

Fig. 5. A. Patient presented initially with fluid in the left chest.
B. Operative pancreatography shows a large collection extending from the tail of the pancreas well up into the mediastinum.
C. Lateral view with the esophagus additionally opacified by barium administered orally, showing that the collection is separate from the esophagus but adjacent. The collection enters the chest through the diaphragm alongside of the esophagus.

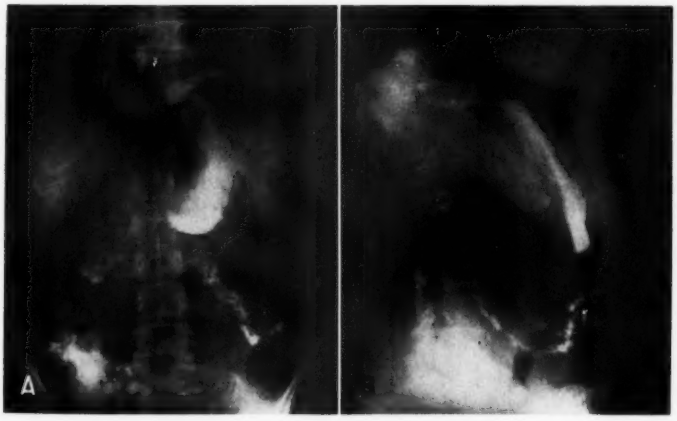

Fig. 6. A. In a patient operated on for adenoma of the pancreas, fluid subsequently appeared in the lesser sac. Anteroposterior view.
B. Lateral view showing fluid in the lesser sac displacing the stomach forward and the bowel downward. The fluid extends up to the posterior third of the diaphragm.

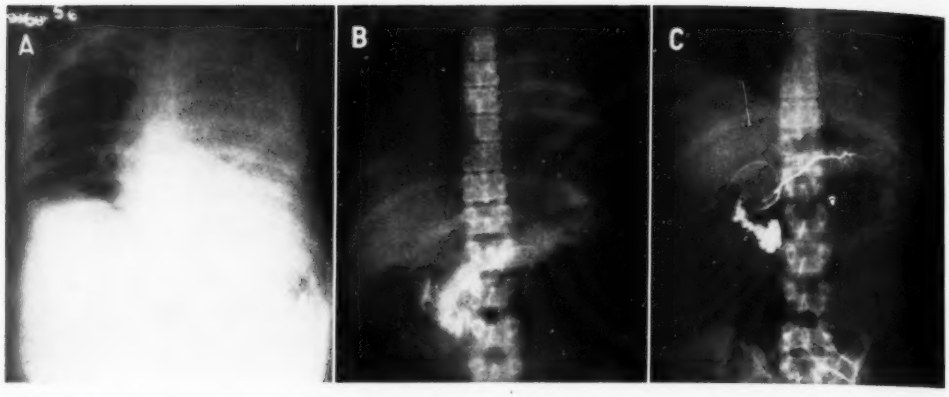

Fig. 7. A. Patient sustained stab wound posteriorly in the left chest near the tenth rib. Note fluid in left chest.
B. Operative pancreatography shows evidence of pancreatitis and leakage of opaque material to left subphrenic region. The left pleural fluid contained blood and pancreatic enzymes.
C. After sphincterectomy. Note absence of pancreatic inflammation and fistula.

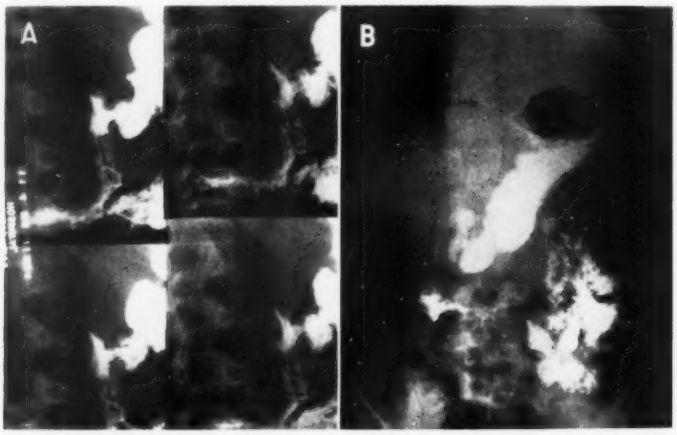

Fig. 8. A. Pancreatic calcifications and irregular enlargement of the pancreas during an acute exacerbation of pancreatitis.
B. Two weeks later, there was a left subphrenic collection with fluid in the left chest which contained pancreatic ferments.

distances as far as the left iliac fossa, often assuming a cyst-like shape.

These collections usually communicate with the pancreas by fistulous tracts which can be filled during operative or postoperative pancreatography. A fistulous tract may open through the abdominal wall to the overlying skin, either spontaneously, after surgery, or as a result of penetrating or other wounds.

General Abdominal Roentgen Manifestations: Varying amounts of exudate may be present in the peritoneal cavity. This is evidenced by a uniformly increased density throughout the abdomen and absence of normal organ outlines due to the loss of the surrounding contrasting fat. There is an increase in the spaces between the loops of bowel. The properitoneal fat layer will disappear.

The diaphragm is elevated and the flanks bulge. The loops of small bowel, the stomach, and the colon (including the rectum) will exhibit gaseous distention (adynamic ileus).

Fluid in the lesser peritoneal sac because

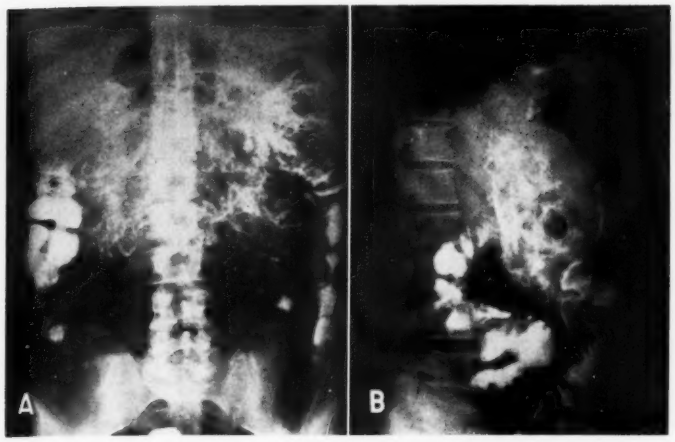

Fig. 9 (Case presented through the courtesy of Dr. F. F. Ruzicka, Jr.). A. Barium enema study revealing multiple fistulas extending from the transverse colon toward the region of the pancreas.

B. Lateral view, showing multiple fistulas from the transverse colon extending to the pancreas. The pancreas is enlarged and contains many gas collections as a result of a gas bacillus infection.

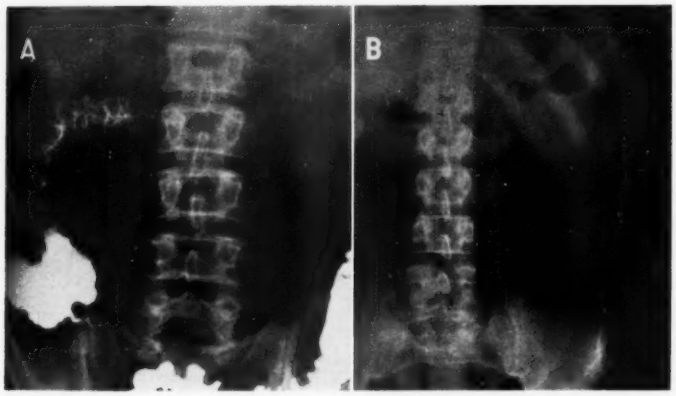

Fig. 10. A. Deformity of the region of the cecum and appendix as a result of perityphlitis which, on surgery, was shown to be connected retroperitoneally with the pancreas which was itself the site of subacute pancreatitis.

B. Displacement of the partially gas-filled stomach by a mass which, on surgery, was found to be a pancreatic collection which connected retroperitoneally with a similar collection in the left iliac fossa.

of its anatomic location produces displacement of the stomach forward. The fluid extends upward to the posterior third of the diaphragm and downward, dissecting between the second and third layers of the omentum.

Roentgen Manifestations Involving the Diaphragm and Chest: Both halves of the diaphragm in the early stages may show slight elevation and restriction of motion. Later, immobility may set in. These changes are usually more pronounced in degree and appear earlier on the left side. If recovery occurs, the left side is the last to return to normal.

In later stages, the subphrenic regions may become the sites of extrapancreatic collections. In such instances there is localized elevation of the diaphragm related to the underlying collection. A sympathetic pleural effusion may form at the involved base.

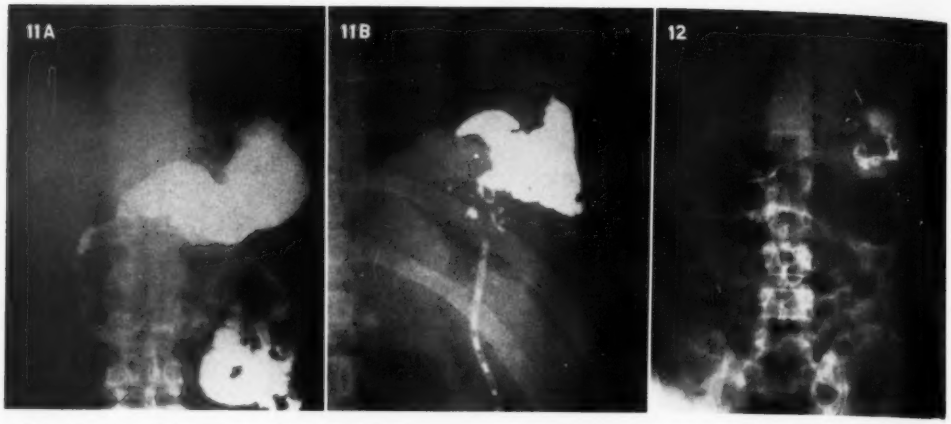

Fig. 11. A. Enlargement of the duodenal loop due to a resolving acute pancreatitis. There is a right subphrenic collection with rupture through the right diaphragm into the right pleural cavity, where an empyema was found.

B. Opacified subphrenic abscess after left loin drainage and fistulography.

Fig. 12. Operative pancreatography shows leakage of opaque material from the pancreatic tail following an accident. Leakage resulted from a collection extending from the pancreatic tail toward the hilus of the spleen.

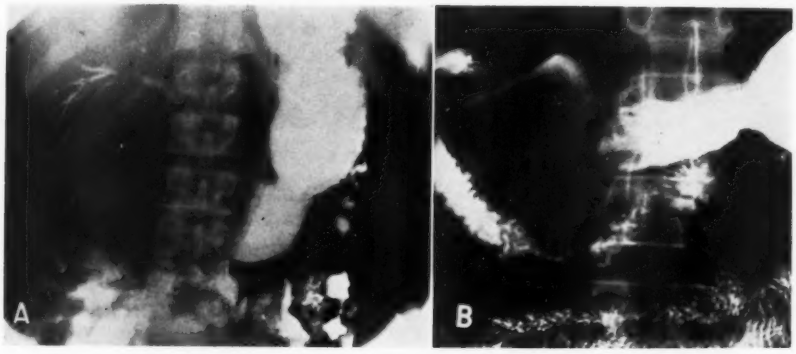

Fig. 13. A. Large pancreatic abscess producing a pressure defect upon the distal portion of the stomach and upon the entire duodenum. The abscess had perforated into the stomach and biliary tract. At surgery a fistula was found from the stomach to the biliary tract to the pancreatic abscess.

B. Large pancreatic abscess producing regional pressure defects. This later perforated and formed subhepatic, perihepatic, and subphrenic abscesses.

The subphrenic collection may perforate through the diaphragm into the mediastinum or into the pleural cavity, producing an empyema. On occasion, the sympathetic pleural fluid or the empyema may extend into the interlobar fissures.

Linear horizontal focal patches of atelectasis may be seen in either lung base under varying conditions.

Roentgen Manifestations Involving the Abdominal Wall: In acute pancreatitis the lateral margins of the left psoas and quadratus lumborum muscles may become indistinct and ill defined due to local edema or to fluid in the peritoneal cavity. In the presence of peritoneal fluid or ileus, there may be bulging of the flanks and of the anterior abdominal wall.

There may result a fistulous communication from the pancreatic area to the anterior wall of the abdomen spontaneously, postoperatively, or as the result of penetrating or other wounds.

Roentgen Manifestations Involving the Left Kidney: Along with the indistinctness of the left psoas muscle contour, there may

occur obscuration of the left kidney outline. This may result from the implication of its surrounding contrasting fat. The extrapancreatic collection may surround the kidney, producing the roentgen manifestations of a perinephritic abscess. On occasion, pressure from a regional extrapancreatic collection upon the kidney may displace it downward or outward, or there may be pressure on the left renal artery and vein, with subsequent impairment of the function of the left kidney. In such instance there may be a resultant hypertension. If the extrapancreatic collection is large enough and firm in consistency, it may press upon the left ureter and produce dilatation of the left urinary tract above this level.

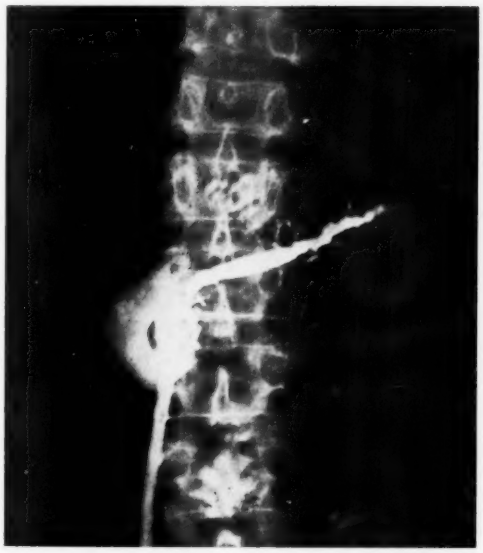

Fig. 14. Fistulography from the anterior abdominal wall shows the drain to be in the pancreatic duct. This followed surgery. The patient's pancreatic juice was thus inadvertently siphoned off through the drain.

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SUMMARIO IN INTERLINGUA

Aspectos Migratori De Collectiones Inflammatori De Origine Pancreatic

Intra dece annos, 30 patientes esseva incontrate in qui collectiones inflammatori de origine pancreatic migrava verso varie regiones in le abdomine o le thorace. In multe casos iste collectiones inflammatori occurreva a un distantia como phase initial del morbo e simulava abscessos local, abscesso perinephritic, abscesso subphrenic, un fistula, empyema, un massa mediastinal, appendicitis o perityphlitis, abscesso in le fossa sinistro-iliac, un collection in le minor sacco peritoneal, e un ver sacco. Le manifestationes roentgenologic es illustrate.

The Roentgen Appearance of Gastric Argentaffinoma

RUBEM POCHACZEVSKY, M.D., and ROBERT S. SHERMAN, M.D.

THE PURPOSE OF the study to be reported here was to determine the roentgenologic appearance of argentaffinoma of the stomach and to report 4 cases of this rare tumor, 3 primary in the stomach and 1 with metastases involving that organ. Bensaid (3) states that gastric argentaffinomas represent only 1 per cent of all carcinoids. Lattes and Grossi (24) found records of only 5 carcinoids of the stomach in the Presbyterian Hospital files from 1910 to 1955. During that time 1,236 carcinomas of the stomach were encountered. To our knowledge there are now 59 published cases of gastric argentaffinoma (5, 6, 8, 12, 16, 20, 24, 29).

Argentaffinomas originate from the Kulschitzky cells of the crypts of Lieberkühn, as demonstrated by Gosset and Masson (19) and Masson (33), who considered these tumors to be of endocrine origin because of the resemblance to the chromaffin cells of the paraganglia. Carcinoids appear almost exclusively below the esophagus in the gastrointestinal tract, particularly in the region of the appendix, although there have been a few instances of these tumors in ovarian teratomas (15, 35). They are also found in the bronchi (43).

While appendiceal argentaffinomas are almost invariably benign, the same is not true for the extra-appendiceal variety, including gastric carcinoids (29). Of MacDonald's 149 cases of extra-appendiceal carcinoids, 16 per cent had spread to distant organs (29). In a review of 237 small bowel argentaffinomas by Ariel (1), metastases were found to be present in 59 (24.9 per cent). Forty-seven gastric argentaffinomas in which thorough pathological examination was reported included 13—approximately 30 per cent—which showed metastases. Most of the metastases were confined to the regional lymph nodes (6, 9, 21, 24, 37, 41, 46, 47). Four of the cases with metastases had hepatic deposits (9, 16, 29, 40) and 1 showed ovarian involvement (32).

Consequently, whenever an argentaffinoma of the stomach is diagnosed, the possibility of its malignant nature should be considered. Even in the presence of metastasis, however, the course is apt to be slow and long-term survival possible. Three of the 5 patients with gastric argentaffinoma reported by Lattes and Grossi (24) are still living, ten, thirteen, and thirteen years after operation, in spite of the fact that 2 had histologically proved regional metastases. In fact, there appear to be only 2 cases recorded in which gastric argentaffinoma was the direct cause of death. One of these patients died of disseminated disease (40) and the other of massive and uncontrollable hemorrhage from an ulcerated gastric carcinoid (8).

Argentaffinomas of the stomach can occur at almost any age. The youngest patient reported was fifteen (28) and the oldest eighty-nine (2). Most are past forty, and there is an equal sex incidence. Symptomatology is variable. Ulcer-like complaints are frequent. Seventeen tumors were incidental autopsy findings (2, 4, 9, 10, 17, 21, 34, 35, 37, 39, 41, 42).

Recently Isler and Hedinger (22) and Thorson *et al.* (44) recognized a malignant carcinoid syndrome in which high blood levels of serotonin are found. This substance, it is postulated, is secreted by the tumor cells (14, 26). An increase of the excretion product of serotonin, 5-hydroxyindolacetic acid, also occurs in the urine. The syndrome is further characterized by partial cyanosis, diarrhea, pul-

[1] From the Department of X-ray Diagnosis, Memorial Center and James Ewing Hospital, New York 21, N. Y. Accepted for publication in June 1958.

monary stenosis of the valvular type, tricuspid regurgitation, and attacks of bronchial asthma.

A single report of gastric argentaffinoma associated with a carcinoid syndrome has been found (16). This patient had extensive hepatic metastases. In the case described by MacDonald (29) there were multiple argentaffinomas of the jejunum with hepatic metastases and only one nodule in the stomach.

In 20 of the 59 cases of gastric carcinoids found in the literature radiological studies were done, but for only 13 are the films reproduced (5, 6, 7, 12, 18, 20, 23, 28, 30, 31, 47). These usually showed a sharply circumscribed polypoid filling defect of rounded shape. This pattern occurred in 11 of the 13 cases. In 1 there was a suspicion of a duodenal ulcer (18) and in 1 an ulcer crater was seen on the posterior wall of the stomach (12). No stalk was demonstrated in any of the 13 tumors. The polypoid filling defects were covered by mucosa, which, with 2 exceptions (5, 30), seemed to have a normal appearance. A small patch of barium was noted in the center of these 2 lesions, which was correctly interpreted as indicating ulceration. Three of the 7 cases in which x-ray reproductions were not published were reported as being negative roentgenologically (8, 25, 45). Two were said to show polypoid filling defects (13, 16) with a deeply penetrating gastric ulcer also present in 1 (16). In the sixth case "pyloric obstruction" was described (38) and in the seventh "distortion of the mucosa high in the lesser curvature" (46).

Multiple lesions were twice (13, 23) demonstrated radiographically, although several tumors were also present in 1 other patient (25). The site of most of the growths was in the body of the stomach, with almost equal involvement of the lesser and greater curvature sides, the antrum, and the pyloric region. Only occasionally was the fundus or the cardia the place of apparent origin (Table I).

TABLE I: LOCATION OF TUMOR IN THE STOMACH IN 37 CASES

Body (13, 10, 6, 12, 24, 24)	6	cases
Lesser curvature (2, 4, 36, 47, 41, 30, 30, 46)	8	"
Greater curvature (40, 45, 31, 28, 8)	5	"
Antrum (34, 18, 23, 7, 21, 21, 5)	7	"
Pylorus (2, 32, 38, 28, 27, 16, 24)	7	"
Fundus (17, 20)	2	"
Cardia (25, 24)	2	"
	37	

The smallest lesions discovered roentgenologically were 1.5 cm. in diameter (7, 30). One of the largest was an ulcerated tumor 8 × 11 cm., reported by Wirts (47). The case described by Earp (12) involved the entire body and fundus of the stomach, with invasion of the spleen, pancreas, and colon. In most of the cases reported the diameter was approximately 2 cm.

In an attempt to gain further insight into the morphological characteristics of gastric argentaffinoma, all the gross pathological descriptions accompanying the 59 reported cases were evaluated and summarized. There were 40 such descriptions. In 16 cases (32, 17, 13, 18, 23, 47, 41, 30, 28, 24, 5, 16, 12, 8) an ulcerated lesion was described. This corresponds to an incidence of 40 per cent. The remaining 24 tumors were said to be small submucous nodules (2, 34, 17, 4, 38, 45, 36, 25, 9, 37, 30, 31, 28, 7, 27, 10, 21, 24, 20, 6). The smallest nodule measured 0.3 × 0.4 × 0.3 cm. and was an incidental finding at autopsy (2).

CASE REPORTS

CASE I: S. W., a 49-year-old woman, was admitted for hysterectomy, with a steadily enlarging uterus thought to contain "fibroids." She had been asymptomatic except for nervousness antedating the climacteric, palpitations for seven to eight years, and a vague pain in the right lower quadrant for two years. She was told that she had high blood pressure.

On Dec. 11, 1951, a subtotal hysterectomy was done. The operation also revealed enlargement of the ovaries, which was thought to be due to carcinoma, a 2-cm. implant on the dome of the bladder, several small deposits in the omentum, and a 2-cm. nodule on the free edge of the liver. A bilateral salpingo-oöphorectomy and a resection of the omentum were performed. The pathological report was bilateral ovarian granulosa-cell tumor with metastases to omentum and fibromyomas of the uterus with endometrial hyperplasia. Because of the his-

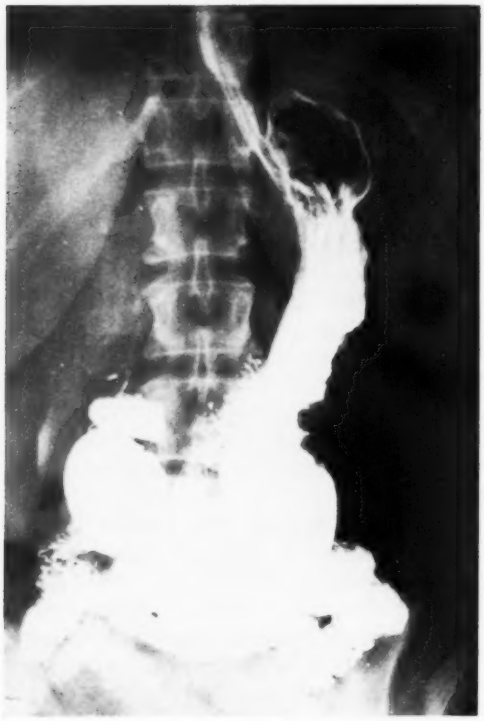

Fig. 1. Case I: Malignant carcinoid on the greater curvature side of the body of the stomach, presenting as a 3.5-cm. polypoid mass with surface ulceration.

tologic appearance, an investigation of the intestinal tract was suggested.

Except for a massive bloody bowel movement on the fourth postoperative day, the patient did well. Because of this episode and also in view of the pathologist's report, an x-ray examination of the stomach was done, although there had been no previous complaints referable to the gastrointestinal tract. The roentgen report, dated Jan. 24, 1952, described the esophagus as normal. Within the pars media of the stomach, projecting intraluminally from the greater curvature, was a fungating mass approximately 3.5 cm. in diameter, with an excavation approximately 1.5 cm. in diameter (Fig. 1). The findings were considered consistent with carcinoma.

On Feb. 29, a subtotal gastrectomy was done, revealing a polypoid mass in the pars media, with a suggestion of a crater in the center. There were palpable metastases in the peritoneum overlying the diaphragm and in the liver. One of the largest of these was 2 cm. in diameter. Between the greater curvature and the splenic vein was a nodule measuring approximately 2.5 cm.

The pathological report described the lesion as a firm thickening of the mucosa measuring 1 cm., involving an area 3.5 cm. in diameter, with an irregular ulcer 2 cm. in length and 1.5 cm. in width in the central portion. The microscopic report was malignant carcinoid of the stomach. Histologically this tumor was said to be identical with the ovarian tumors. On Oct. 16, 1953, a 1-cm. submucosal vaginal nodule was biopsied. Histologic section revealed metastatic cancer consistent with carcinoid.

Follow-up examinations were done for the next four years and to date there has been no evidence of pelvic or intra-abdominal tumor. The patient has been almost completely asymptomatic except for occasional palpitations and pain in the left arm. There has been no cyanosis, flushing, dyspnea ,or diarrhea. A determination of the 5 hydroxyindolacetic acid excreted in the urine was reported as normal.

Comment: The tumor in this case is a malignant argentaffinoma, primary in the stomach, with hepatic and ovarian metastases presenting a Krukenberg-like picture. Following total hysterectomy, oöphorectomy, and subtotal gastrectomy the patient has been observed for more than five years and, to date, is almost completely asymptomatic. This case is an example of long-term survival and the slow progress of disease often seen in malignant argentaffinomas. The radiologic finding was a large, irregularly shaped polypoid lesion with central ulceration in the greater curvature area.

CASE II: H. K., a 42-year-old white male, was admitted April 4, 1956, with a four-year history of increasing generalized skin pigmentation, palpitations, paresthesias, arthralgia, and dyspnea. For three years he had had persistent diarrhea, with as many as ten bowel movements daily, and for two years he had had hot flushes associated with exposure to cold. He gave a long history of heavy drinking and smoking. On May 12, 1954, an exploratory laparotomy had been done elsewhere, and biopsy of a stomach tumor was reported as showing carcinoid.

Physical examination on admission revealed generalized dark pigmentation of the skin, a blood pressure of 120/80, and marked hepatomegaly with evidence of collateral venous circulation. The heart was enlarged and there were a harsh systolic murmur at the apex and a high pitched pulmonic murmur.

A gastrointestinal series done on May 2, 1954, showed a 5-cm. polypoid tumor in the midportion of the greater curvature of the stomach. The stomach was displaced somewhat to the left and posteriorly by a markedly enlarged liver (Fig. 2).

Skeletal surveys on Sept. 25 and Oct. 4, 1956, revealed destructive defects of both humeri, the left femur (Fig. 3), left clavicle, right scapula, and 3d dorsal vertebra. The lesion of the right scapula had an expanded, sun-burst appearance.

Liver biopsy on June 25, 1956, showed metastatic carcinoid. Needle aspiration of the right scapula also yielded tissue consistent with carcinoid.

Radiation therapy (1 MEV) was given to the liver area from June 26 to July 30, 1956, with a tumor dose of 3,000 r through two opposing portals which included the stomach. There was no apparent clinical change, but a repeat gastrointestinal series on July 16, 1958, showed considerable decrease in the size of the previously described polypoid gastric

Fig. 2. Case II: Malignant argentaffinoma of stomach with carcinoid syndrome. The lesion is a polypoid one located in the body, on the greater curvature side.

mass. The patient also received radiotherapy to the right scapula, 3d thoracic vertebra, sternum, and left humerus, with considerable symptomatic relief. During his hospitalization several determinations of 5-hydroxyindolacetic acid in the urine were found to range from 10 to 12 mg. per day. On several occasions, however, the output was as high as 19 mg. per day. Terminally the course was marked by increasing lethargy, coma, dyspnea, cyanosis, ascites, and low blood pressure. The patient died on Jan. 10, 1957.

At necropsy three separate neoplasms were found in the stomach. One was a 1-cm. nodule in the midportion, on the posterior wall, adjacent to the greater

Fig. 3. Case II: Pathological fracture of femur due to metastasis from gastric carcinoid.

curvature and covered by gastric mucosa except near the tip, which showed a superficial erosion. A microscopic section revealed carcinoid tumor, most of which was confined to the mucosa and submucosa, with small nests of tumor cells in the muscle coats. A second nodule, 3 mm. in diameter, was noted on the anterior wall adjacent to the lesser curvature. Microscopically this also was carcinoid, for the most part within the locally expanded mucosal layer. In the same section, at about 1 cm. distance, was another carcinoid, 5 mm. or less in diameter, involving the mucosal layer. There were large metastatic deposits in the liver as well as abdominal and mediastinal nodes. There were also widespread skeletal metastases. The heart showed moderate cardiac hypertrophy without evidence of organic valvular disease.

Comment: Case II is the second reported in the literature of primary argentaffinoma of the stomach with a malignant carcinoid syndrome and the third with death directly due to the disease. It is, we believe, the first case of primary gastric argentaffinoma in which metastases to bone were found. There were also hepatic, lymph node, and brain metastases. As in Case I, the presenting radiologic feature was a large polypoid lesion in the greater curvature of the stomach with obvious destruction of the mucosa. Apparently

Fig. 4. Case III: Defect in gastric fundus due to metastasis from malignant argentaffinoma of ileum.

the patient had three separate gastric carcinoids. There was evidence of considerable regression of the gastric involvement following radiotherapy.

CASE III: L. B., a 54-year-old white woman, was admitted July 22, 1957, with a history of malaise, severe diarrhea, 30-lb. weight loss, and nausea for one year. She had experienced several episodes of facial edema, flushing, puffiness of the dorsum of the hands, and palpitation after intake of moderate amounts of alcohol. The physical examination revealed hepatosplenomegaly and fullness in the periumbilical region. A Grade II systolic murmur was heard in the aortic and pulmonic areas.

Radiologic examination of the gastrointestinal tract showed a filling defect in the fundic area of the stomach (Fig. 4.), thought to be the result either of extrinsic pressure or of an intrinsic lesion. A small bowel series showed segmentation, puddling, fixation, and irregularity of the lower ileum, with an abnormal mucosal pattern (Fig. 5).

The 5-hydroxyindolacetic acid excretion was elevated to 40 mg. in twenty-four hours.

At laparotomy, Aug. 26, 1957, the ileum was found to be bound together in a large mass, with subserous nodules also present. The liver was enlarged, with multiple metastatic deposits. No intrinsic lesion of the stomach was found, but the fundus was compressed and deformed by large nodes. There were also large pre-aortic nodes, with involvement of the duodenum. Frozen section of a liver nodule revealed metastatic carcinoid.

The patient was treated with radiation therapy (I MEV) to the abdomen, including the liver, through two opposing fields, from Sept. 22 to Dec. 4, 1957, receiving a tumor dose of 2,850 r from the anterior and 2,685 r from the posterior port. During the last month of life the condition began to deteriorate, with frequent bouts of vomiting, anorexia, and a drop in blood pressure. Death ensued on Jan. 20, 1958.

Fig. 5. Case III: Segmentation, puddling, fixation, and irregularity of the lower ileum, indicating multiple tumor masses due to malignant carcinoid.

Necropsy findings of special interest were as follows: The pulmonary valve showed thickening of the edges of the leaflets, with some degree of pulmonary stenosis. Sections revealed fibrous proliferation. The liver was filled with metastatic nodules varying from a few millimeters to about 3 cm. in diameter. Metastatic carcinoid was also found in the left ovary. The stomach showed no mucosal involvement. The ileum was bound together in a mass extending from the duodenum to an area around the cecum, and contained multiple polypoid tumor masses measuring from a few millimeters to 2 cm. Microscopic section showed that the tumor was growing mainly in the mucosa and submucosa.

Comment: Case III shows multiple malignant argentaffinomas of the lower ileum presenting with a carcinoid syndrome and producing extensive metastases, with an extrinsic pressure type of defect due to metastases in the fundus of the stomach.

A valvular pulmonary stenosis was also present.

CASE IV:[2] H. T., a 67-year-old man, was admitted Aug. 18, 1958, with a three-month history of hiccoughs following meals and a slight weight loss. He was otherwise asymptomatic. Physical examination revealed nothing of significance.

A gastrointestinal series done prior to admission (Aug. 5, 1958) showed a well circumscribed polypoid lesion at the cardia, measuring 8 × 7 × 5 cm. (Fig. 6). The roentgen diagnosis was gastric cancer.

On Aug. 27, a proximal subtotal gastrectomy was performed, revealing a large tumor in the cardia and fundus, with regional node involvement. All gross disease was removed. There were no postoperative complications and at the time of this report the patient was still under observation.

The pathologist's report read as follows: "Along the lesser curvature, there is a fungating mass measuring about 8 × 8 cm. and raised above the mucosal surface for a distance of 1 to 2.5 cm. This rounded mass has a red papillated border. There is a central deep ulceration measuring 2 cm. in diameter. This central ulceration is delineated with difficulty and is not lined with any necrotic material. The mass is composed of stony hard yellow tissue."

The microscopic diagnosis was malignant carcinoid with involvement of all lesser curvature nodes.

Comment: Case IV is another example of a polypoid carcinoid of the stomach which produced few symptoms. It could not be differentiated roentgenologically from other polypoid lesions of the stomach.

Fig. 6. Case IV: Well circumscribed polypoid lesion at the cardia, diagnosed as gastric cancer.

DISCUSSION

On the basis of a review of the gross morphology of gastric argentaffinomas in the literature, as well as an evaluation of the roentgen appearance described and experience with 3 additional cases, one concludes that the roentgen findings are somewhat variable and nonspecific. Almost always, however, they were indicative of some type of neoplasm, most often "polyp" or gastric carcinoma. The great majority of gastric carcinoids present as small, sharply circumscribed, polypoid filling defects of rounded shape, covered with an apparently smooth mucosa. In a number of instances central ulceration occurred on the surface of the polypoid mass. Occasionally gastric carcinoids are multiple. They may be located anywhere within the stomach, although they are less commonly found in the cardia and fundic areas. In none of the cases studied was a correct diagnosis made on the x-ray appearance alone. There was no single instance of a purely or predominantly infiltrative defect.

SUMMARY

Three cases of primary argentaffinoma of the stomach are added to the 59 already described, one being the second known example with the carcinoid syndrome. An argentaffinoma of the ileum with carcinoid syndrome, associated with a gastric defect roentgenologically, is also reported.

A review of the radiologic findings in primary gastric argentaffinoma on the basis of the literature and the authors' experience is presented.

Argentaffinoma, although a rare tumor, should be included in the differential diagnosis of polypoid filling defects in the stomach, especially if the patient has a long history of stomach disease and if

[2] Case IV was seen after acceptance of this paper for publication.

the symptomatology is at all suggestive of a carcinoid syndrome.

A purely infiltrative defect roentgenologically in the stomach is apparently never caused by gastric argentaffinoma.

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SUMMARIO IN INTERLINGUA

Le Apparentia Roentgenographic De Argentaffinoma Gastric

Tres casos de argentaffinoma primari del stomacho es addite al 59 jam describite in le litteratura. Un del nove casos es le secunde exemplo con le syndrome carcinoide. Un argentaffinoma del ileum con syndrome carcinoide, roentgenographicamente associate con un defecto gastric, es etiam describite.

Es presentate un revista del constatationes radiologic in argentaffinoma gastric primari super le base del litteratura e del experientia personal del autores.

Argentaffinoma es un tumor rar, sed illo deberea esser includite in le diagnose differential de polypoide defectos de replenamento in le stomacho, specialmente si le patiente ha un longe hostoria de gravamines gastric e si le symptomatologia es del toto suggestive de un syndrome carcinoide.

Il pare que un purmente infiltrative defecto in le stomacho, a roentgenologicamente parlar, es nunquam causate per argentaffinoma gastric.

Azygography[1]

SOLOMON SCHWARTZ, M.D., JACK HANDEL, M.D., and SAMUEL CANDEL, M.D.

THOUGH THE AZYGOS system is an important anastomotic channel between the superior and inferior venae cavae, little attention has been paid to it and to its intimate relation to the paravertebral veins.

The arch of the azygos vein is often seen on the postero-anterior film of the chest and, according to Burke (2), was described by Nuvoli on frontal tomograms. Fleischner (5) mentioned its dilatation in congestive failure and Ellis (4) discussed possible confusion with more significant shadows. Stauffer (10) succeeded in catheterizing the azygos vein in 1951, and in the same year Mellins (9) showed free communication between the femoral and azygos veins when contrast material was injected through a catheter in the saphenous vein.

Lessmann (7, 8) and Tori (12) give credit for successful intraosseous venography to Erhardt and Kneip in 1943. Drasnar (3) in 1946 reported on infusions and transfusions by way of the bone marrow and stated that he had performed intraosseous venography in 1942. Lessmann's work included intracostal venography. Tori (12) and Süsse (11) wrote exclusively on azygos opacification. The former injected the thoracic spinous processes, a technic which clearly showed the communication between the paravertebral and azygos systems, though in our hands it met with inconsistent results. Süsse reported on intracostal injection and mentions that Fischgold and Prospenzi had used thoracic spinous processes and Prospenzi and Ficara had also injected ribs. Other papers on this subject, appearing in the foreign literature, are not readily available.

The azygos vein begins adjacent to the first or second lumbar vertebra as a continuation of the ascending lumbar vein. It enters the thorax through the aortic hiatus and arches forward at the fourth thoracic vertebra, over the root of the right lung, to enter the superior vena cava. On its right, it receives the subcostal and intercostal veins, the upper three or four of the intercostal veins draining by a common trunk, the superior intercostal

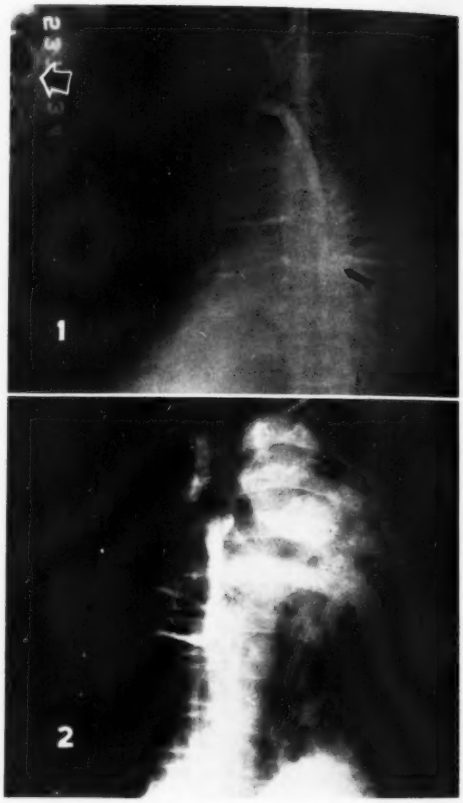

Fig. 1. Malignant right pleural effusion. Bilateral injection. The azygos lies to the left of the vertebral column. A left intercostal vein drains directly into the azygos at T-8 (lower right arrow). A short segment of the accessory hemiazygos is filled (upper right arrow). Right axillary vessels are noted (large left arrow).

Fig. 2. Atelectasis of the left upper lobe secondary to metastatic carcinoma of the skin. Unilateral injection. The azygos vein lies far to the left of the midline, apparently moving with other mediastinal structures.

[1] From the Departments of Radiology and Internal Medicine, The Jewish Hospital of Brooklyn, Brooklyn, N. Y. Presented at the Eastern Conference of Radiologists, New York, N. Y., March 7–9, 1957. Accepted for publication in June 1958.

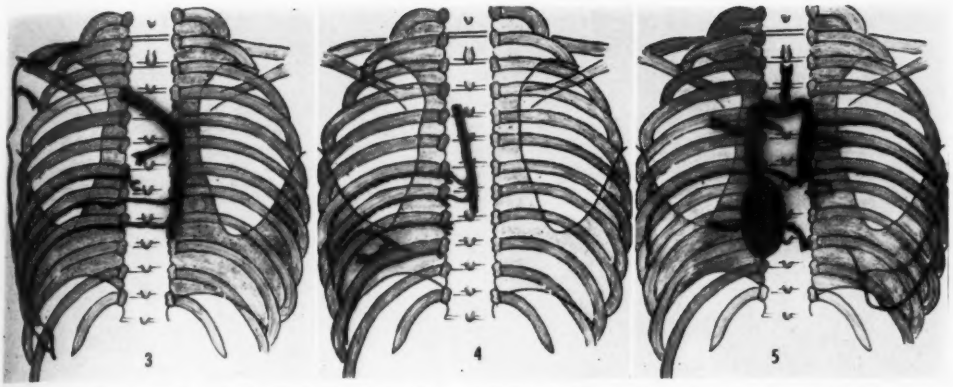

Fig. 3. Mitral stenosis. Unilateral injection. Arrows point to axillary veins and to the azygos, lying far to the left of the midline, displaced, perhaps, by a large left atrium.

Fig. 4. Carcinoma of the tongue and lung. Unilateral injection. Several intercostals are filled. Arrow points to phrenic vessels. The bronchogenic lesion was peripheral and in no way impinged on the azygos.

Fig. 5. Carcinoma of the parotid with pulmonary parenchymal metastases. Mediastinum uninvolved. Bilateral injection. The arch of the azygos is open in the frontal projection. Arrows point to the azygos far to the left of the midline, the arch, superior vena cava, and right atrium. Only a single intercostal is filled on the right.

vein. The left intercostals communicate with the azygos *via* the accessory hemiazygos and hemiazygos veins. The hemiazygos, the thoracic continuation of the left ascending lumbar vein, receives the lower four or five intercostal veins, and empties into the azygos at the level of T-9. The accessory hemiazygos is made up by the confluence of intercostal veins between T-3 and T-9. It drains into the azygos or hemiazygos at T-8.

This anatomical description is taken from Gray (6) and corresponds to that of other texts. It appears to be stylized. We have not consistently produced opacification of the accessory hemiazygos and hemiazygos and have shown intercostal veins that are supposed to communicate with the hemiazygos draining directly into the azygos. In addition, the thoracic portion of the azygos often appears to be much further to the left than has been indicated (Fig. 1). In some cases marked levoposition may be a function of left atrial enlargement and has been seen with atelectasis of the left lung (Figs. 2 and 3). Ordinarily, injection of a single rib results in opacification of several intercostal veins (Fig. 4). Filling of axillary and phrenic vessels, without evidence of azygos obstruction, is not uncommon. Süsse feels that filling of only one intercostal vein or extensive filling of axillary veins is indicative of obstruction. We cannot agree (Figs. 4, 5, 9, 10, 12).

Bachman believes that retrograde flow is a manifestation of obstruction of the azygos system (1A). Complete block is obvious and is accompanied by retrograde flow (Figs. 6 and 7). Internal obstruction (increase in intra-azygos pressure) can be determined only by catheterization of the vessel. Further, it is not known what role in antegrade or retrograde flow is played by rib porosity, the size and number of intramedullary channels, injection rate, quantity and viscosity of material injected, patient posture, and phase of respiration. Certainly, we have repeatedly observed retrograde flow without clinical evidence of obstruction (Figs. 8 and 9).

Despite these problems, the chief value of azygography, as suggested by Bachman (1), lies in demonstration of operability of mediastinal masses. The procedure is much simpler than angiocardiography.

With experience, the technic of injection becomes easy. The soft tissues and periosteum over the rib to be injected are infiltrated with 2 per cent Novocaine and an 18-gauge spinal needle is inserted obliquely. The posterior portion of the

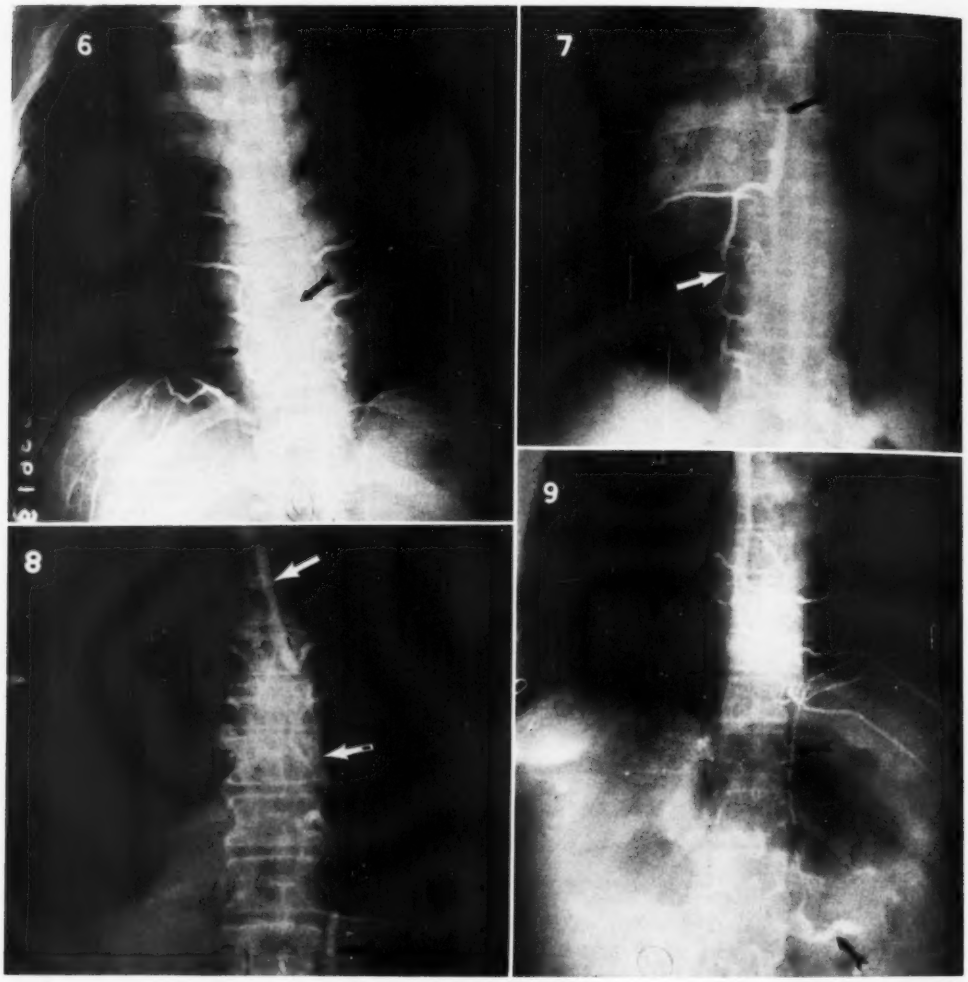

Fig. 6. Superior mediastinal mass totally obstructing azygos. Bilateral injection. Flow is entirely into the abdomen through paravertebral vessels (arrows).

Fig. 7. Bronchogenic carcinoma blocking arch of azygos (upper arrow). Bilateral injection unsuccessful on left. Flow is downward into abdomen through the azygos and paravertebral vessels (lower arrow).

Fig. 8. Bronchogenic carcinoma, right; no superior mediastinal component. Bilateral injection. Arrows point to superior vena cava, azygos, hemiazygos, and left ascending lumbar vein.

Fig. 9. Carcinoma of the breast; no mediastinal metastases. The left inferior phrenic vein (upper arrow) is filled and communicates with the left renal vein (lower arrow).

rib is injected for azygos opacification and the anterior portion for internal mammary opacification. Bilateral simultaneous injections are made into the eighth or ninth ribs to increase the contrast density of the opacified anastomotic channel. This level is chosen because of the strategic relationship of the eighth and ninth intercostal veins to the azygos-hemiazygos system. Ten cubic centimeters of 50 per cent Hypaque is injected as rapidly as possible and films are taken at the rate of one per second for eight seconds. Serial films are essential to demonstrate slow flow and extent of block (Figs. 10 and 11). Initially 90 per cent Hypaque was used but, because its viscosity impeded the rate of injection, with resultant poorer visuali-

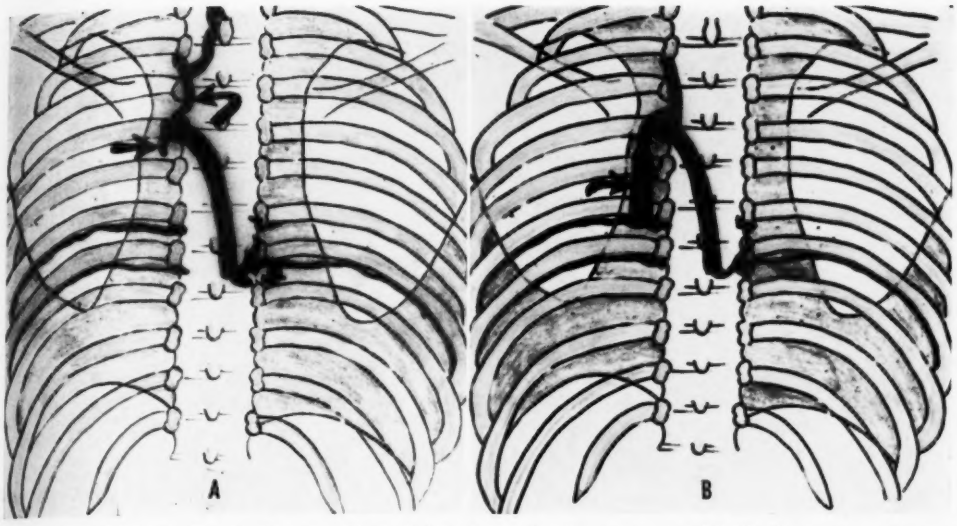

Fig. 10. Metastatic pleural effusion. Bilateral injection. A. Contrast material fills the azygos. Arrows point to beginning of superior vena cava and right superior intercostal. Only a single intercostal is filled on the left. B. Seven seconds later there is good opacification of the superior vena cava.

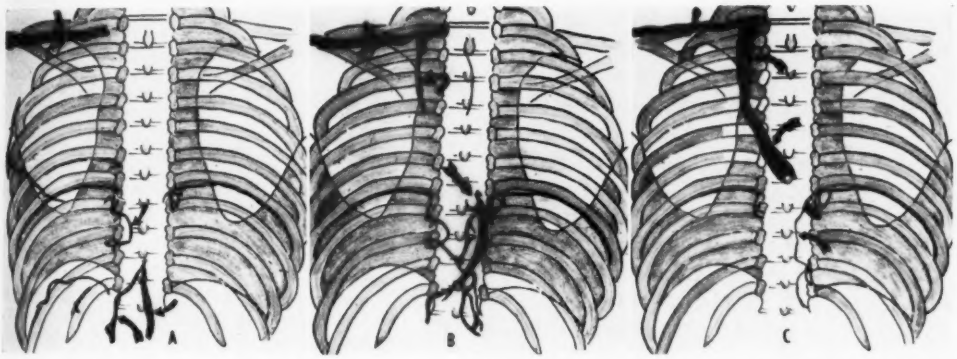

Fig. 11. Superior mediastinal syndrome. Bilateral injection and simultaneous superior vena cavagram. A. Retrograde filling of the paravertebral system (upper arrow) and filling of the right ascending lumbar vein (left arrow) and of an anastomotic channel (right arrow). B. A later film shows an oblique cut off in the proximal azygos due to tumor (lower arrow) and caval obstruction (upper arrow). C. A still later film shows filling of the distal azygos (lower arrow) coming from reflux through the obstructed superior vena cava (upper arrow).

zation of the system during the critical period, it was replaced.

Pain is a variable occurrence and we have the impression that it is in inverse relationship to the porosity of the ribs. It is maximum at the moment of injection and cannot be obviated by instillation of an anesthetic into the medullary cavity. Injection of Novocaine or saline appears to be just as painful as injection of the contrast material. A dull ache may persist for several hours. Despite the recommendation of several authors, however, we have not found the pain to be of such magnitude as to warrant general anesthesia. We do advise barbiturate premedication, especially in apprehensive patients.

Local extravasation, pleural irritation, and pneumothorax have been complications encountered early in the course of study, and occur in direct ratio to the

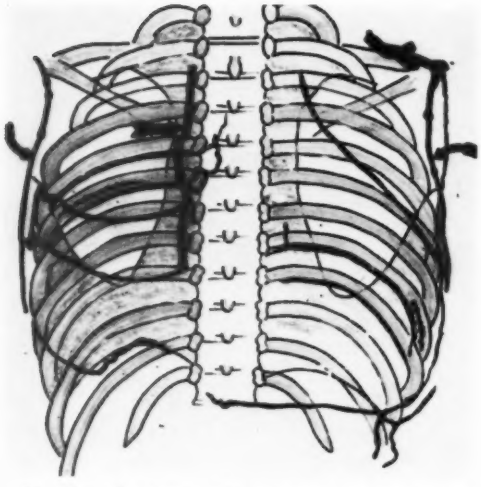

Fig. 12. Carcinoma of the breast; no mediastinal involvement. Bilateral anterior injection. The anterior portions of several right intercostals are filled. Arrows point to bilateral axillary and right internal mammary veins.

experience of the injector. Pneumothorax occurred once, in our first patient.

Several variables contribute to difficulty in study of the physiology of the azygos system. Flow appears to be much more rapid in a porous rib and in the supine position. The Valsalva maneuver may retard flow. Efforts at measuring intracostal pressures with the patient supine and erect and in various phases of respiration have not met with much success. Injections by an automatic injector rather than by hand may overcome variable injection rate.

Anterior rib injections will show the internal mammary vein (Fig. 12). Fischgold and Ambrose, according to Süsse, use the sternum for this purpose, but he prefers the rib.

SUMMARY

Intracostal venography is a simple method of demonstrating the azygos system. It re-emphasizes the continuity of the intercostal, azygos, hemiazygos, renal, and vertebral vessels, and the role they may play in spread of tumor. Anatomically, there is considerable variation from standard text-book descriptions. Practically, this is a method for demonstration of inoperability of mediastinal masses.

The technic of the procedure is described. It is much simpler than angiocardiography

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SUMMARIO IN INTERLINGUA

Azygographia

Le autores opina que le valor principal del technica azygographic jace in su uso pro demonstrar le operabilitate de massas mediastinal. Le methodo usate per le autores es le methodo de venographia intra-ossee. Le injection del substantia de contrasto es effectuate, bilateralmente, a in le portion posterior del octave o none costa, precedite per un injection de Novocaina in le suprajacente histos molle e in le periosteo. Hypaque de 50 pro cento es le substantia de election, e le expositiones es facite con un rapiditate de un omne secunda durante octo secundas. Le possibile complicationes include extravasation local, irritation pleural, e pneumothorace. Lor frequentia es directemente proportional al experientia del operante. Le dolor non esseva satis sever pro requirer anesthesia.

Iste manovra re-sublinea le facto que le vasos intercostal, azygotic, hemi-azygotic, renal, e vertebral representa un sol continuitate e le rolo que illos ha possibilemente in le dissemination de tumores.

The Postoperative Lumbar Myelogram[1]

MAURICE L. SILVER, M.D., EUGENE A. FIELD, M.D., CAROLL M. SILVER, M.D., and STANLEY D. SIMON, M.D.

LUMBAR MYELOGRAPHY is a well established radiographic technic in the diagnosis of lumbar disk protrusions. In a series of more than 700 "positive" myelograms, *i.e.*, showing some abnormality, followed by lumbar hemilaminectomy for excision of protruded or extruded intervertebral disks, we have been impressed by the accuracy and reliability of this diagnostic procedure. We shall not, in this presentation, concern ourselves with the actual technic of lumbar myelography or the surgical technic for correction of lumbar disk protrusions. Rather, we shall limit our discussion to the problem of the *postoperative* myelogram, that is to say, a lumbar myelogram performed in a patient who has undergone laminectomy or hemilaminectomy for disk herniation. In our series of 38 cases, representing almost 5 per cent of the total number of laminectomies performed by the authors, we have gained certain impressions and come to certain conclusions which serve as the basis of this report.

All of the myelographic examinations were carried out by the members of this group according to a uniform technic, employing 6 to 10 c.c. of Pantopaque introduced by a No. 18 spinal needle into the lumbar subarachnoid space and withdrawn as completely as possible following the examination. The indications for repeat myelography, as for the initial study, were signs and symptoms of lumbar nerve root irritation or compression, considered on clinical grounds to be consistent with the possibility of lumbar disk protrusion. Myelographic examinations were carried out in patients with objective neurological signs and in cases with long standing subjective complaints of low back or sciatic pain in whom conservative therapy had failed.

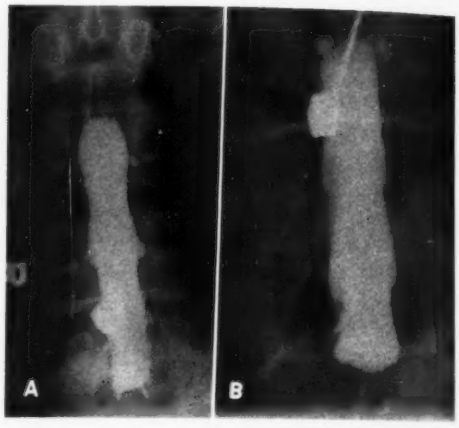

Fig. 1. Patient A. C. A. Preoperative myelogram, Feb. 20, 1953, showing block at lumbosacral joint. Herniated lumbosacral disk removed in 1953.
B. Postoperative myelogram, Aug. 11, 1955, two and a half years following disk surgery. Note filling of dural sac at lumbosacral pouch.

The average period between the laminectomy and the performance of postoperative myelography was eleven months; the time interval varied from eight days to twenty-three months.

In this report, we analyze the findings in 38 cases. In all, the initial myelogram had shown a definite lesion diagnosed as consistent with the protrusion of one or more intervertebral disks in the lumbar region. At various intervals following surgery, recurrence of symptoms, with or without new injury, or failure of the patient to improve led to myelographic re-examination. Of the 38 cases, 22 (58 per cent) showed postoperative myelographic findings which could be considered within normal limits. In the remaining 16 cases the presence of a myelographic defect either at the same level or at another level led to a second operation, with confirmation of gross pathology consistent with the myelogram.

On a review of the *16 re-operated cases*

[1] Presented at the Forty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16–21, 1958. For Discussion, see p. 392.

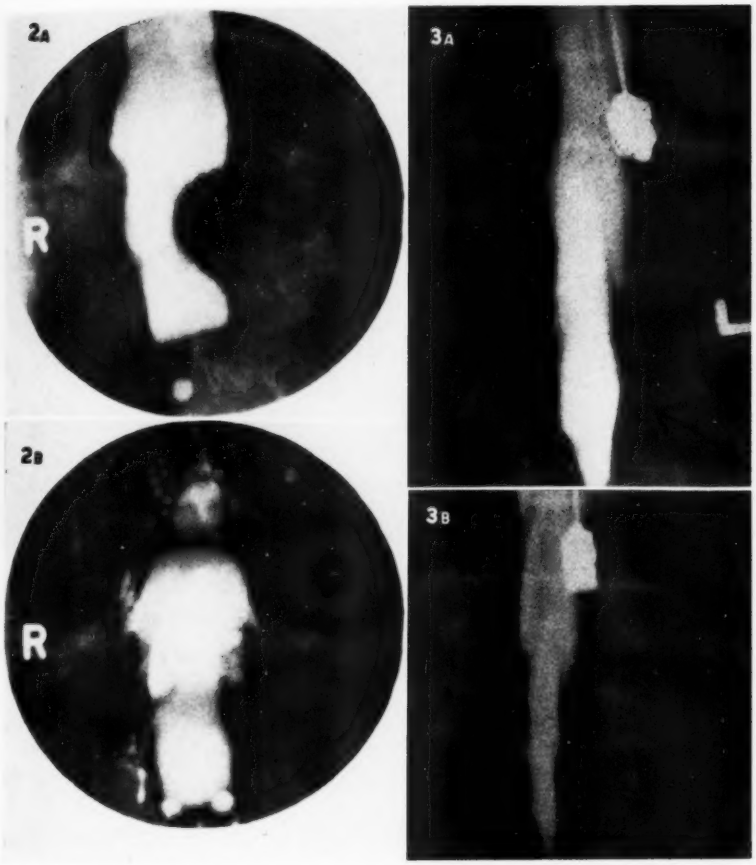

Fig. 2. Patient F. G. A. Preoperative myelogram, Sept. 19, 1958, showing marked lumbosacral defect on left. Extruded disk removed at this level, September 1958.

B. Postoperative myelogram, Oct. 21, 1958, carried out with residual Pantopaque in lumbar canal. Note marked improvement in myelographic appearance. Patient is clinically well.

Fig. 3. Patient P. P. A. Preoperative myelogram, Jan. 21, 1954, showing shallow defect at left side of lumbosacral joint. Herniated lumbosacral disk removed same month. Good clinical recovery.

B. Postoperative myelogram, Jan. 13, 1955, following new injury. Note bilateral narrowing of Pantopaque column at lumbosacral joint. Recurrent lumbosacral disk found and removed, with good result.

and an analysis of the repeat myelograms, the following observations were made:

A. *In 5 cases* the original myelographic defect was no longer present, but a new defect at another lumbar level was found, consistent with a new herniation. This was confirmed by a second laminectomy.

B. *Eleven cases* showed evidence of a myelographic defect at the original level. The important question was: Did this represent postoperative "adhesions" or "arachnoiditis," as an inevitable sequel to the disk surgery, or did it represent a *recurrence* of disk herniation at the previous operative level? In the former instance, "adhesions" would be increased by re-operation and surgery would be contraindicated. In the latter case (recurrence), re-operation would be imperative. Re-operation in these 11 cases indicated conclusively that a definite defect in the repeat myelogram at the previously operated level is evidence of a *recurrence* of herniation at that level.

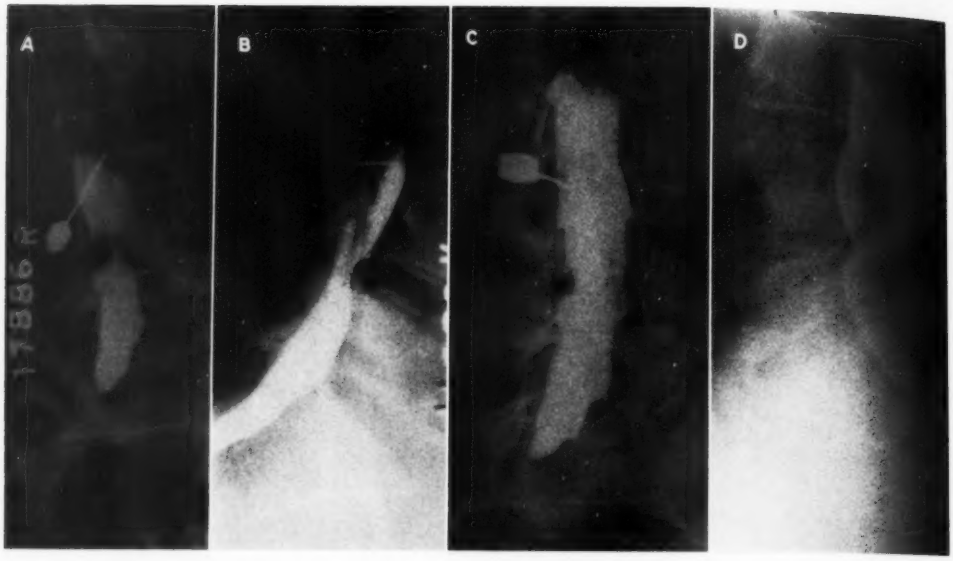

Fig. 4. Patient A. L. A and B. Preoperative myelograms, 1954, showing large defect at L-4 interspace. Extruded disk at L-4 removed in 1954.

C. Postoperative myelogram, March 11, 1957. Note small notched defect at right side of L-4 interspace Recurrent fourth lumbar disk removed in March 1957.

D. Postoperative myelogram of same case, showing concavity at L-4 interspace on lateral view, more marked than in original preoperative myelogram.

In the 22 cases of postoperative myelography which showed an essentially normal picture with no gross defect, it was concluded that no further surgery was indicated and that conservative therapy should be followed. These patients had recurrent symptoms referable to the lower back and involved lower extremity at some time following laminectomy. Five of the 22 had specific injuries at various intervals after clinical recovery, with recurrence of symptoms and disability. The remaining 17 had partial or complete relief of symptoms following surgery, with later insidious recurrence of pain and disability. As a result, repeat myelographic studies were considered to be indicated and were performed.

A study of the 22 patients in this group, treated by conservative measures and followed for one to ten years, with an average follow-up of five years, reveals that 19 (86 per cent) made a good clinical recovery and are actively engaged in productive work. Three patients have had persistence of appreciable complaints referable to the back and lower extremity.

SUMMARY

Postoperative lumbar myelography was performed in 38 cases because of persistence or recurrence of symptoms and disability. Twenty-two (58 per cent) showed myelographic findings considered to be within normal limits. The remaining 16 cases (42 per cent) showed definite myelographic abnormalities at the same or different interspaces. All 16 patients were again operated upon and the myelographic findings were correlated with the gross pathology.

Analysis of these 16 re-operated cases leads to the conclusion that a definite defect on the postoperative myelogram is evidence of disk protrusion of surgical significance. Such defects cannot be attributed to "adhesions" or other sequelae of previous surgical intervention.

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SUMMARIO IN INTERLINGUA

Le Myelogramma Lumbar Post-Operatori

Post-operatori myelographia lumbar esseva effectuate in 38 casos a causa de persistentia o recurrentia de symptomas o invaliditate. Vinti-duo (58 pro cento) produceva constatationes considerate como intra le limites normal. Le remanente 16 casos (42 pro cento) monstrava definite anormalitates myelographic al mesme o altere interspatios. Omne le 16 patientes del secunde gruppo esseva re-operate, e le constatationes myelographic esseva correlationate con le pathologia grossier.

Le analyse del 16 casos duce al conclusion que un definite defecto in le myelogramma post-operatori es evidentia de protrusion de disco de signification chirurgic. Tal defectos non pote esser attribuite a "adhesiones" o altere sequellas de un previe intervention chirurgic.

In le 22 casos de myelographia post-operatori que exhibiva un essentialmente normal tableau sin defecto grossier, il esseva concludite que nulle chirurgia additional esseva necessari

The Roentgenologic Manifestations of Meningiomas in the Region of the Tuberculum Sellae[1]

ROBERT L. TUCKER, M.D., COLIN B. HOLMAN, M.D., COLLIN S. MacCARTY, M.D., and MALCOLM B. DOCKERTY, M.D.

ALTHOUGH MENINGIOMAS of the tuberculum sellae had been described previously, Cushing and Eisenhardt (1) made the first extensive study of these tumors, emphasizing the fact that they seldom caused gross roentgen abnormalities. More recently Weyand and Camp (2) and di Chiro and Lindgren (3) have shown that evidence of such tumors often can be detected by careful roentgenographic evaluation of the sella turcica.

Carotid angiography and cerebral pneumography have been used widely for the study of suprasellar tumors. List and Hodges (4) and Wood (5) have found angiography useful. Wickbom (6) believed that pneumoencephalography and carotid angiography should be used as complementary diagnostic examinations.

Schlezinger and Teplick (7) and Dyke and Davidoff (8) described the abnormalities noted on pneumoencephalographic examinations. Many of the published series have included suprasellar tumors other than meningiomas of the tuberculum sellae.

PRESENT STUDY

The present study was undertaken to reevaluate abnormal appearances in standard head roentgenograms from a series of cases of meningioma of the tuberculum sellae, and to appraise the angiographic and pneumographic abnormalities encountered. The series included 51 patients operated on at the Mayo Clinic between Jan. 1, 1946, and July 1, 1956. Thirty-nine were women and 12 were men. The average age of the group was 48.4 years, with a range from twenty-nine to seventy years. Seventy per cent of the patients were between the ages of forty and fifty-nine.

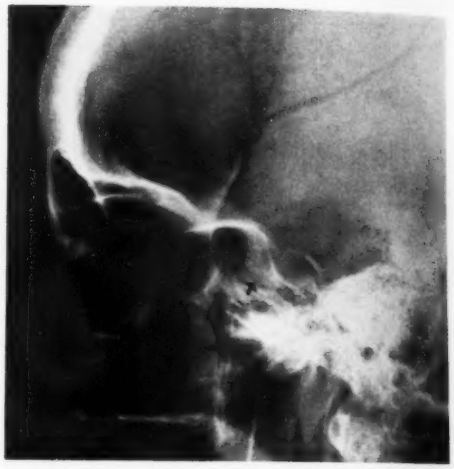

Fig. 1. Minimal osteomatous changes involving the planum sphenoidale. There is an osteoma in the sphenoid sinus (arrows).

TABLE I: HISTOPATHOLOGIC CLASSIFICATION OF MENINGIOMAS OF THE TUBERCULUM SELLAE

Type		Per cent
Meningotheliomatous		82
Psammomatous	29	
Nonpsammomatous	53	
Fibrous		6
"Active"		12
Meningotheliomatous	10	
Fibroblastic	2	
Total		100

The histopathologic findings are summarized in Table I. Twelve per cent of the meningiomas were hypercellular and active, presenting mitotic figures. Since it is not yet agreed that such cellularity is certainly indicative of malignant change,

[1] From the Mayo Foundation (R. L. T., Fellow in Radiology), and the Sections of Roentgenology (C. B. H.), Neurologic Surgery (C. S. M.), and Surgical Pathology (M. B. D.), Mayo Clinic and Mayo Foundation, Rochester, Minn. Abridgment of a thesis submitted by Dr. Tucker to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Radiology. The Mayo Foundation, Rochester, Minn., is a part of the Graduate School of the University of Minnesota.

Presented at the Forty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16–21, 1958. For Discussion, see p. 392.

we have chosen to leave the question open and designate these lesions as "active."

Correlations With Tumor Size: The relationship between the size of the tumor and the roentgen findings was studied. The estimate of size was based on the recorded observations of the surgeons and pathologists (which necessarily are gross judgments) Thirty-four tumors were of average dimensions, weighing 25 gm. or less, with a diameter not exceeding 2.5 cm.; 17 were large, measuring up to 6 cm. in diameter and weighing as much as 60 gm. The size was considered important. The large tumors produced the most notable angiographic abnormalities. They caused decalcification of the posterior clinoid processes and the dorsum sellae more frequently than did the typical tumors and were more frequently responsible for unusual neurologic findings.

Fig. 2. Extensive calcification in a meningioma of the tuberculum sellae. Also, osteomatous changes have involved the planum sphenoidale and the anterior clinoid processes; the dorsum sellae is shortened, and the posterior clinoid processes are decalcified.

FINDINGS IN STANDARD ROENTGENOGRAMS OF THE HEAD

Sites and Affected Tissues: The abnormalities detected in standard roentgen examinations are summarized in Table II. Evidence of osteomatous change was the most common finding, and such a change was also the most significant roentgen abnormality, since an osteoma of the planum sphenoidale, the tuberculum sellae, or the anterior clinoid processes frequently indicates that a meningioma is attached at that site. The osteomas involved the planum sphenoidale more often than the tuberculum sellae.

Fig. 3. Osteomatous formation involving the planum sphenoidale and the tuberculum sellae. The osteoma has a spongy appearance, and the dorsum sellae is shortened.

The osteomatous reactions in these locations varied somewhat in appearance. In a few cases the entire planum sphenoidale was irregularly thickened by a dense homogeneous bony reaction (Fig. 1); in others the osteomas were mound-like and appeared to be composed of spongy bone. Occasionally they were as much as 1.5 cm. in height (Figs. 2 and 3). Osteomas involving the anterior clinoid processes were associated with similar changes at the tuberculum sellae and planum sphenoidale in some but not all instances. No evidence of osteomatous change on the posterior clinoid processes was seen.

Osteoma in the sphenoid sinus has not been reported previously in association with meningiomas of the tuberculum sellae, but

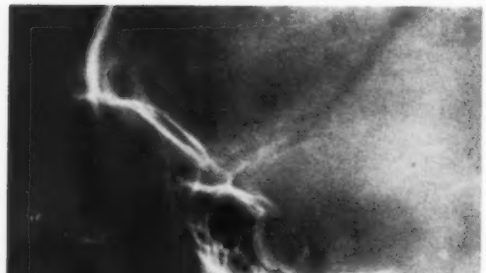

Fig. 4. Dislocation of pineal calcification posteriorly and downward. The posterior clinoid processes and the left anterior clinoid process are decalcified. The dorsum sellae is shortened.

TABLE II: ABNORMALITIES DISCLOSED BY STANDARD ROENTGENOGRAMS IN 51 CASES

Roentgenographic Abnormalities	Instances	
Osteomatous changes		26
Osteomas of the tuberculum sellae and planum sphenoidale	17	
Osteomas of the planum sphenoidale without involvement of the tuberculum sellae	6	
Osteomas of the anterior clinoid processes	6	
Osteomas of the sphenoid sinus	4	
Decalcification of the tuberculum sellae and of the planum sphenoidale or anterior clinoid processes or both		14
Decalcification of one or both posterior clinoid processes		22
Decalcification of posterior clinoid processes and shortened dorsum sellae	14	
Calcification of tumor		4

in one case from this series it was the most prominent abnormality discoverable roentgenographically (Fig. 1). In this and other instances the osteoma in the sinus had the same general appearance as those arising from the superior surface of the tuberculum sellae and planum sphenoidale. They usually appeared to be composed of spongy bone and measured as much as 1.5 cm. in thickness. Instead of projecting upward, they projected down into the sinus from the inferior surfaces of the planum sphenoidale and the tuberculum sellae. The osteomas were seen only in well aerated sphenoid sinuses, and their striking appearance was caused by the contrast of the even, sharply demarcated, free edge of the tumor against the air in the sinus.

Posterior displacement of the pineal calcification was noted on 2 roentgenograms in this series (Fig. 4). This finding seemed unusual, since small midline basofrontal tumors do not ordinarily displace the pineal body. Actually the 2 tumors which caused this posterior displacement were

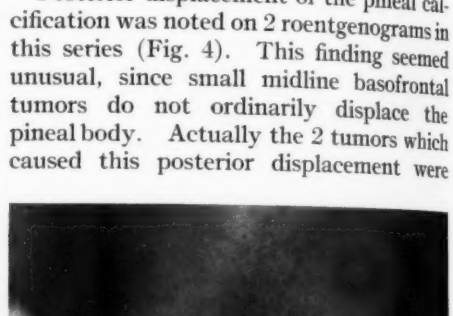

Fig. 5. Towne projection of the head. The left posterior clinoid process is decalcified, and is only faintly discernible. The right posterior clinoid process is normal. The Towne projection often is valuable in evaluation of the dorsum sellae and the posterior clinoid processes.

large, atypical meningiomas of the tuberculum sellae. None of the meningiomas of average size produced pineal displacement.

Secondary Changes: Decalcification of the anterior and posterior clinoid processes, and of the tuberculum or the floor of the sella, or both, was another frequent roentgen observation. When this was minimal, the fine dense line representing the cortex of the bone could not be seen; with more advanced change the bone underlying the cortex was affected, and the trabeculae were only faintly discernible. Decalcification was also associated with blunting or thinning of the anterior clinoid processes in the standard roentgenograms of 8 cases, and decalcification of the posterior clinoid processes was seen in 22. In 14 of the latter instances the dorsum

sellae appeared abnormally shortened, and its superior aspect flattened. These changes are frequently associated with a suprasellar tumor (Fig. 5) but, in the absence of decalcification of the posterior clinoid processes, it is difficult to be certain that a short dorsum sellae does not represent an anatomic variation.

Instead of the normal regular, well defined cortex of the tuberculum sellae and the planum sphenoidale, an irregular, ill defined cortex was observed in the standard roentgenographic views in 10 cases. This irregularity was minimal, with bony excrescences protruding 1 to 2 mm. above the level of the normal cortical margin. The appearance suggested a probable early stage in the development of osteomatous changes. The change was usually a subtle one and assessment of its significance was difficult unless other corroborative roentgen abnormalities were present. In the evaluation of any one study, correlation of all the roentgen changes was important.

Primary Changes: Calcification was a significant finding. In 2 cases this was of such extent as to permit determination of the size of the tumor (Fig. 2). In 2 other instances, regions of tumor calcification were detected. In these 4 cases, marked osteomatous changes on the planum sphenoidale and the tuberculum sellae were also noted. The presence of the latter changes in company with calcification in the tumor helps to differentiate meningiomas from other suprasellar tumors, such as craniopharyngiomas. These other tumors often calcify but are not ordinarily accompanied by osteomas.

A comparative study of the histopathologic findings and the roentgen features showed that, when tumor calcification was discernible on the standard roentgenogram, it was extensive and the tumor was psammomatous in type. The fibrous meningioma was the only histologic type that never produced osteomatous changes.

SPECIAL PROJECTIONS

When the findings on standard roentgenograms of the head were equivocal, additional roentgen technics were often used. Localized stereoscopic views of the sella sometimes demonstrated minimal osteomatous changes or decalcification that involved the anterior clinoid processes and the tuberculum sellae. No abnormalities of the optic foramina *per se* were noted in this study, but these views provided an additional projection for evaluation of changes of the planum sphenoidale and the anterior clinoid processes. By the use of tomography it was possible to demonstrate osteomatous changes and decalcification clearly when they were not readily apparent on standard films (Fig. 6). Granger's view was used infrequently, but demonstrated osteomatous changes of the planum sphenoidale in 1 case.

Fig. 6. Midsagittal tomogram demonstrating an osteoma involving the planum sphenoidale. The dorsum sellae is shortened.

FINDINGS IN CEREBRAL ANGIOGRAMS

Meningiomas of the tuberculum sellae were closely related anatomically to the anterior cerebral arteries and the terminal portions of the internal carotid arteries. Arising from the planum sphenoidale and the tuberculum sellae, these tumors developed a spherical shape. Angiography showed that the horizontal components of both anterior cerebral arteries and the anterior communicating artery usually were elevated and displaced posteriorly by the tumor beneath them, forming an arterial

Fig. 7. Half-axial angiographic projection. The anterior cerebral arteries are elevated and stretched over the suprasellar tumor. The terminal portion of the internal carotid artery is displaced laterally. The angle between the internal carotid and anterior cerebral arteries is obtuse. There are tumor arteries over the sella turcica.

arch (Figs. 7 and 8). Careful evaluation of the half-axial and stereoscopic lateral projections was necessary to obtain a 3-dimensional concept of the displacement of the anterior cerebral artery, the elevation of the horizontal portion being demonstrated on the half-axial projection and the posterior displacement on the lateral projection.

The terminal portion of the internal carotid artery was often displaced laterally, and its supraclinoid portion was straightened and appeared to be erect. When the horizontal portion of the anterior cerebral artery was elevated and the carotid siphon was displaced laterally, these arteries formed on the half-axial projection a characteristic obtuse angle, the normal apparent angle being acute.

In 1 case the horizontal portion of the anterior cerebral artery did not appear to be elevated in the half-axial projection. Study of the lateral view demonstrated that the carotid siphon was unusually erect (Fig. 9). The terminal portion of the siphon and the anterior cerebral artery had been elevated as a unit and the relationship of the anterior cerebral artery to the siphon was normal. Elevation of the proximal portion of the right middle cerebral artery was noted in the same angiogram. These changes had been caused by a large tumor that extended laterally into the right middle fossa.

In 3 angiograms the terminal portion of the siphon was displaced posteriorly and compressed downward (Figs. 8 and 10). Two of the tumors causing this type of change were large.

Fig. 8. Compression of the siphon downward and posteriorly. The anterior cerebral artery is displaced posteriorly and superiorly, forming a curve with its concavity facing anteriorly.

Irregularity of the size of the lumen of the internal carotid or the anterior cerebral arteries, or both, was noted in more than half of the angiograms. Meningiomas of the tuberculum sellae often surround and compress these arteries and presumably cause this appearance.

The deep cerebral veins were not visualized completely in all of the 17 angiograms studied; but among those in which the veins were demonstrated, the typical meningiomas of the tuberculum sellae seldom caused significant abnormalities. Two cases showed equivocal elevation of the basal vein of Rosenthal. Elevation or displacement of the internal cerebral veins was not seen. The large meningiomas of the tuberculum sellae, on the other hand, caused marked changes. Only 3 large tumors in this series were studied by carotid angiograms, but all 3 displaced the internal cerebral

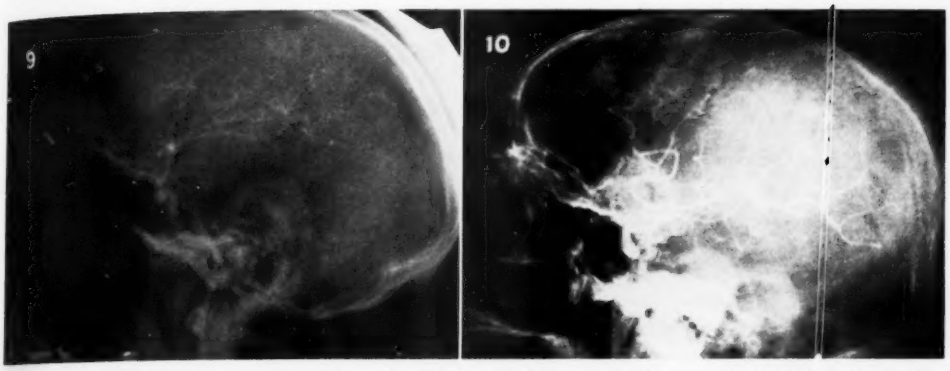

Fig. 9. Carotid siphon erect and straightened. Tumor arteries are seen above and behind the sella turcica. The elevation of the anterior cerebral arteries does not appear to be marked because of the extreme erect position of the siphon. The proximal portion of the middle cerebral artery is also elevated.

Fig. 10. Diffuse concentration of opaque medium in the tumor above the sella turcica. (The concentration became more marked in the venous phase.) The terminal portion of the siphon is displaced somewhat posteriorly.

veins posteriorly and superiorly as well as elevating the basal vein of Rosenthal.

An interesting abnormality of the deep cerebral circulation was noted in 1 case: the internal cerebral vein, the basal vein of Rosenthal, and the great vein of Galen were opacified early in the arterial phase of angiography. This unique appearance was attributed to arteriovenous shunts within the vascular system of the meningioma.

Abnormal arteries supplying the meningiomas were demonstrated in 4 cerebral angiograms, where their presence was one of the most important among the signs noted. In 1 case a diffuse concentration of opaque medium was demonstrated late in the arterial phase of the study (Fig. 10) and revealed the extent of the tumor. In another case dilated vessels were present throughout the tumor, thereby revealing its size. In 2 additional cases arteries were seen to connect neighboring major vessels.

FINDINGS IN CEREBRAL PNEUMOGRAMS

Because carotid angiograms have been used so frequently at the Mayo Clinic to study lesions in the region of the tuberculum sellae, only 2 pneumoencephalograms and 1 ventriculogram were made in this series of 51 cases. These did not demonstrate the changes usually thought to accompany the ordinary meningioma of the tuberculum sellae, because the 3 tumors studied were unusually large.

No dilatation of the ventricular system was shown. In all 3 cases the anterior portion of the third ventricle was deformed, and the anterior third ventricle and the anterior horns of the lateral ventricles were displaced posteriorly. Convex filling defects on the inferior surfaces of the anterior horns of the lateral ventricles suggested the presence of a mass in the basofrontal region. In 2 cases the unidirectional lateral shift of the lateral and third ventricles suggested that the lesions were predominantly unilateral. In 1 pneumoencephalogram the cisterna chiasmatis was not outlined by air, and there was a filling defect in the anterior portion of the cisterna interpeduncularis.

COMMENT

Di Chiro and Lindgren found that most suprasellar meningiomas are attached to osteomas that involve the planum sphenoidale rather than the tuberculum sellae, and they expressed the belief that these tumors are not truly meningiomas of the tuberculum sellae. The present study tends to confirm their observation. Seventeen standard roentgenologic examinations demonstrated osteomatous changes involving both the planum sphenoidale and the tuberculum sellae; in 6 additional cases the roentgenograms showed only the planum sphenoidale to be involved. It appears that ordinarily involvement of the planum

sphenoidale was primary and that of the tuberculum sellae secondary. Perhaps the term "meningioma of the tuberculum sellae" is a misnomer, and it may be that we should use the designation "meningioma of the planum sphenoidale." The distance between the two structures is only a few millimeters, however, and the difference between the terms does not appear to be significant.

Osteomatous changes involving the tuberculum sellae, the anterior clinoid processes, and the planum sphenoidale or sphenoid sinus, or both, were demonstrated roentgenologically in more than 50 per cent of the cases in this series. Occasionally tomography or special projections were necessary to verify the presence of their effects. These findings were considered suggestive of a meningioma of the tuberculum sellae. Decalcification of the anterior or posterior clinoid processes or posterior displacement of the calcified pineal or both, or tumor calcification, was sometimes seen in addition to osteomatous changes and provided further evidence of a suprasellar growth. When these changes were identified, carotid angiography ordinarily was not done; but angiograms that were made in such situations confirmed the diagnosis of suprasellar tumor and provided additional information about its size and extent. If the findings on standard head roentgenograms were equivocal or normal, angiography was more important. Under such conditions, it revealed characteristic displacement of the anterior cerebral and the internal carotid arteries, thereby demonstrating the presence of a suprasellar tumor in almost every instance. The recording of abnormal tumor vessels in 4 angiograms suggested that meningioma of the tuberculum sellae was present.

In the study of angiograms it is important to evaluate the course of the internal carotid arteries and the anterior cerebral arteries in both the half-axial and the stereoscopic lateral projections. The changes in one projection must corroborate those in the other. Apparent displacement of arteries seen in only one projection should be considered an equivocal finding. Careful technic is important, since the apparent location and course of these arteries may be altered considerably as a result of faulty positioning.

Additional changes, such as irregularity in the size of the lumen of the arteries and displacement of the deep cerebral veins, may be helpful as secondary evidence substantiating the roentgen diagnosis.

Pneumography was used infrequently in this series of patients. This technic should demonstrate characteristic abnormalities.

SUMMARY AND CONCLUSIONS

Standard head roentgenograms showed abnormalities in 85 per cent of 51 patients with meningiomas of the tuberculum sellae. The anterior clinoid processes, planum sphenoidale, and tuberculum sellae were often involved by osteomatous changes. Osteomas were noted within the sphenoid sinus in 4 standard roentgenograms. Frequently the anterior and posterior clinoid processes and the tuberculum sellae were decalcified. Calcification of tumors was another significant abnormality. Roentgen evidence of increased intracranial pressure was not apparent in any case.

Carotid angiography proved to be a useful technic, especially in the presence of normal or equivocal standard roentgenograms. Elevation and posterior displacement of the horizontal portion of the anterior cerebral artery was a common observation. The terminal part of the carotid siphon usually was abnormally straightened and appeared erect. In 3 cases it was compressed inferiorly and posteriorly. In most angiograms on the half-axial projection the angle formed by the terminal siphon and the horizontal portion of the anterior cerebral artery was obtuse. Abnormal vessels supplying and lying within the tumor were noted in 4 angiograms. These not only indicated that a tumor was present, but in 2 cases revealed its extent.

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SUMMARIO IN INTERLINGUA

Le Manifestationes Roentgenologic De Meningioma In Le Region Del Tuberculo Sellar

Roentgenogrammas standard de capite monstrava anormalitates in 85 pro cento de un serie de 51 patientes con meningiomas del tuberculo sellar. Le processos antero-clinoide, le plano sphenoidal, e le tuberculo sellar esseva frequentemente afficite per alterationes osteomatose. Osteomas esseva notate intra le sino sphenoide in 4 roentgenogrammas standard. Frequentemente le processos antero- e postero-clinoide e le tuberculo sellar esseva discalcificate. Calcification de tumores esseva un altere anormalitate significative.

Angiographia carotidic se provava un technica de utilitate, specialmente in le presentia de roentgenogrammas standard normal o equivoc. Elevation e displaciamento posterior del portion horizontal del arteria cerebral anterior esseva un observation commun. Un evalutation meticulose del projectiones semi-axial e stereoscopic esseva necessari pro obtener un conception tri-dimensional del displaciamento de ille arteria. Le elevation de su portion horizontal esseva demonstrate in le projection semi-axial e le displaciamento posterior in le exposition lateral. Le portion terminal del siphon carotidic esseva anormalmente recte. Su position pareva erecte. In 3 casos illo esseva displaciate posteriormente e comprimite in basso. In le majoritate del angiogrammas, in le projection semi-axial, le angulo formate per le siphon terminal e le portion horizontal del arteria cerebral anterior esseva un angulo obtuse. Vasos anormal que alimentava le tumor e jaceva intra illo esseva notate in 4 angiogrammas cerebral. Istos non solo indicava le presentia de un tumor, sed in 2 casos illos etiam revelava su extension.

Duo pneumoencephalogrammas e 1 ventriculogramma esseva effectuate in iste serie. Illos non demonstrava le alterationes usualmente reguarde como phenomenos typicamente associate con meningioma de tuberculo sellar. Isto se explica per le grande dimensiones del 3 tumores.

Intracranial Meningiomas: A Roentgen Study of 126 Cases[1]

HAROLD G. JACOBSON, M.D., HERMAN W. LUBETSKY, M.D., JEROME H. SHAPIRO, M.D., and CHARLES A. CARTON, M.D.

THE LITERATURE dealing with intracranial meningiomas is voluminous. A large number of articles and monographs have appeared through the years describing the pathology, common locations, clinical features, roentgen findings, and treatment of these tumors. Some of the studies are classic and best read in the original (1–19). In this presentation it is our purpose to evaluate our own material, which consists of 126 proved cases, each including one or more intracranial meningiomas, seen at Montefiore Hospital (New York) in the past thirteen years, and to describe certain roentgen criteria characteristically observed in these lesions. Plain-film evaluation will be emphasized. The use of air studies will be briefly mentioned. The importance of cerebral angiography will be stressed, and the advantages of the biplane method of cerebral angiographic examination will be fully discussed.

TECHNICS

Conventional Roentgenography: Our standard plain-film examination includes stereoscopic postero-anterior, stereoscopic left lateral, single right lateral, anteroposterior Towne-Chamberlain and, in special situations, submentovertex views.

Air Studies: Roentgenograms are obtained in both the horizontal and erect positions in stereoscopic pairs. Stereoscopic brow-down and brow-up views are made, as well as special horizontal-beam temporal horn projections. A Robertson position is added for delineation of the fourth ventricle, and a midline laminagraphic cut for outlining the midline structures, particularly the aqueduct and fourth ventricle.

Cerebral Angiography: Prior to 1956, cerebral angiography was performed in our department with the Fairchild camera, with 9 × 9-inch roll film. For the past two years, we have been using a biplane Schönander film-changing device incorporating two 500-ma generators with 14 × 14-inch cut film, permitting up to thirty exposures in each of the two planes simultaneously. Each sequence may be run as slowly as three films per two seconds, and as rapidly as six films per second. With the patient supine on a special sliding top which fits over the Bucky table, the anteroposterior beam is directed downward (36-inch distance). The head is positioned 3 inches from the anteroposterior film changer. The lateral beam (also 36-inch distance) is directed across the table and the distance between the patient's head and the lateral film changer is 4 to 5 inches. The magnification (and distortion) factors in the anteroposterior plane are in the order of approximately 10 per cent and in the lateral plane approximately 15 per cent, but this has not proved disadvantageous. Actually, the magnification delineates the small vessels more clearly.

A fixed grid is used with each film changer; these grids are specially designed 8:1 focused grids. Standard 4-inch circular extension cones are employed. High-speed screens and standard film are used.

This equipment was originally purchased for specific use in selective catheter angiocardiography, but we have found its adaptation to cerebral angiography surprisingly effective.

In the usual cerebral angiographic examination, a speed of 3 films per two seconds carried through for a total period of

[1] From the Divisions of Diagnostic Radiology and Neurosurgery, Montefiore Hospital, and the Department of Radiology, New York University College of Medicine, New York, N. Y. Presented at the Forty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16–21, 1958. For Discussion see p. 392.

For a significant number of the cases studied, we are indebted to Dr. Leo M. Davidoff. Grateful acknowledgment is due him for affording us the opportunity to review these cases and for all that he has taught us.

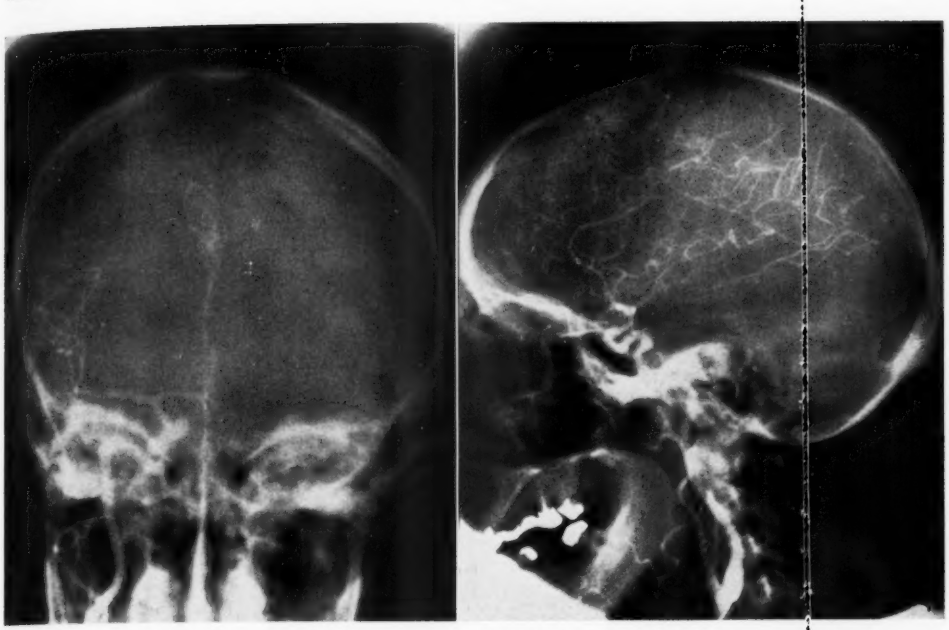


Fig. 1, A and B. Frontal plane and lateral views (14 x 14-inch film size with Schönander apparatus) exposed simultaneously during arterial phase of cerebral angiography, after percutaneous carotid artery injection. The carotid artery bifurcation is well visualized in both planes. The magnification of the cerebral vessels is helpful, while the distortion factor is not disturbing.

nine seconds is sufficient. A total of 10 films in each of the two planes is obtained. For the past two years we have been employing 50 per cent Hypaque, usually 10 c.c., but recently attempts have been made to reduce the amount to 6 or 8 c.c. All injections are made by the percutaneous route. Currently, a hand syringe is used by the neurosurgeons but we are investigating the feasibility of employing the matching Gidlund automatic syringe which we now use in selective catheter angiocardiography. Usually, only one injection of the medium is required because of the simultaneous biplane examination but, rarely, oblique views or a submentovertex projection are found advisable and a second injection may be necessary.

The advantages inherent in the use of the biplane Schönander unit are as follows: (*a*) Scout films prior to the injection are readily obtained. These insure optimum positioning and technic. (*b*) Usually only one injection of medium is needed, thus reducing the potential hazard to the patient. If a second study is necessary for special positioning, *i.e.*, aneurysm delineation, then a second injection only, rather than three or four, as with single-plane examinations, is required. (*c*) Positioning of the patient on the special mobile table is considerably easier than with other serialographic units. (*d*) A larger film area (14 × 14 inches) in each plane permits not only inclusion of the entire

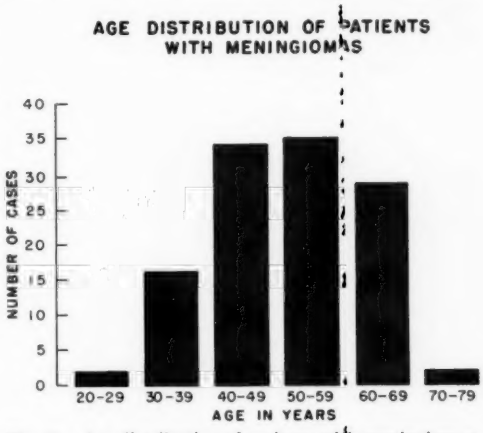


Fig. 2. Age distribution of patients with meningiomas.

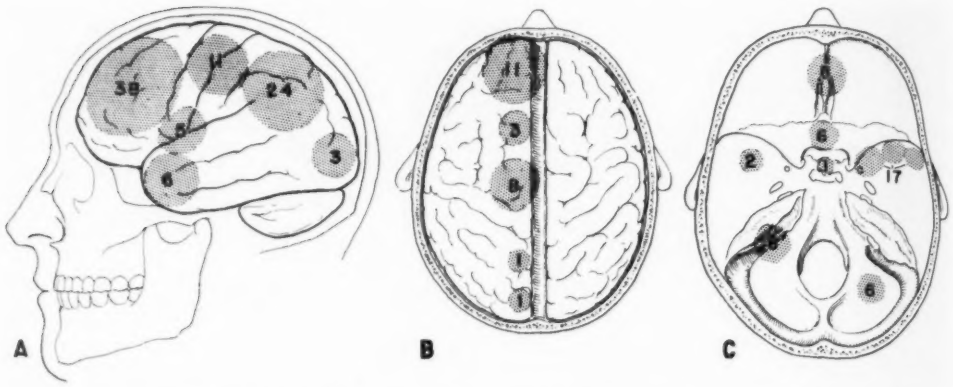


Fig. 3. A. Lateral view showing the location of convexity lesions. B. Demonstration of the distribution of parasagittal lesions from front to back. C. Base view of the skull illustrating the distribution of basilar lesions. In sequential order: Olfactory groove, tuberculum sellae, intrasellar area, sphenoidal ridge, middle fossa, posterior fossa, and cerebellopontine angle.

skull (and face) but the major portion of the neck (Fig. 1). Thus the carotid bifurcation is always seen, with an excellent demonstration of the differential filling of the internal and external carotid artery, as well as determination of technical failures (extravasation, intimal injections, temporary spasm). (*e*) Great flexibility in sequential timing is available. (*f*) The visualization of simultaneously exposed biplane roentgenograms permits a 3-dimensional reconstruction of the vascular system not available with single plane studies. (*g*) Small vessels hitherto difficult to define are magnified sufficiently for detection without loss of clarity. (*h*) The time for the examination is materially shortened. (*i*) Marked reduction in radiation to the operator will result when the problems currently encountered in the use of the matching Gidlund automatic syringe are resolved.

CLINICAL MATERIAL

The age and sex incidence in our series is consistent with that described in the classic literature dealing with meningiomas. Figure 2 shows the age incidence; the greatest number of cases are seen in the fifth to the seventh decades. The proportion of females to males was in the order of 7:4. There was no significant laterality, 66 of the 126 patients showing the lesion on the left side, 53 on the right side, 6 bilaterally, and 1 in the midline.

TABLE I. EVALUATION OF PLAIN FILMS*: 120 CASES†

	Total	Per Cent‡
Normal	27	22.5
Abnormal	93	77.5
Localized hyperostosis	41	44.1
Significant atrophy of dorsum sellae	27§	29.0
Localized increase in vascularity	24	25.8
Psammomatous calcification	19	20.4
Significant pineal shift	18	19.4
Localized bone resorption	15	16.1
Localized spiculation	4	4.3

* A number of cases showed multiple abnormalities on the plain films, *i.e.*, pineal shift and localized hyperostosis, atrophy of the dorsum sellae and increase in vascularity, etc.

† Of the 126 cases, 6 did not have plain films.

‡ Percentages calculated on basis of total abnormals.

§ In a number of such cases an increase in intracranial pressure was undoubtedly present but no attempt was made to list this impression separately, since a combination of sutural widening, thinning of the dorsum, thinning of the inner table, and an increase in digital markings was not found in any one case.

Figure 3 shows the localization of the tumors and indicates the highest incidence in the frontal and parietal regions, 73 of 126 meningiomas being found in the parietal, frontoparietal, and frontal areas (5 patients had multiple tumors). Twenty-three lesions involved the sphenoidal wing or olfactory groove. Twenty-four meningiomas were found parasagittally, most of these occurring in the frontal and parietal regions.

Plain Films: An evaluation of the plain films, available in 120 of the 126

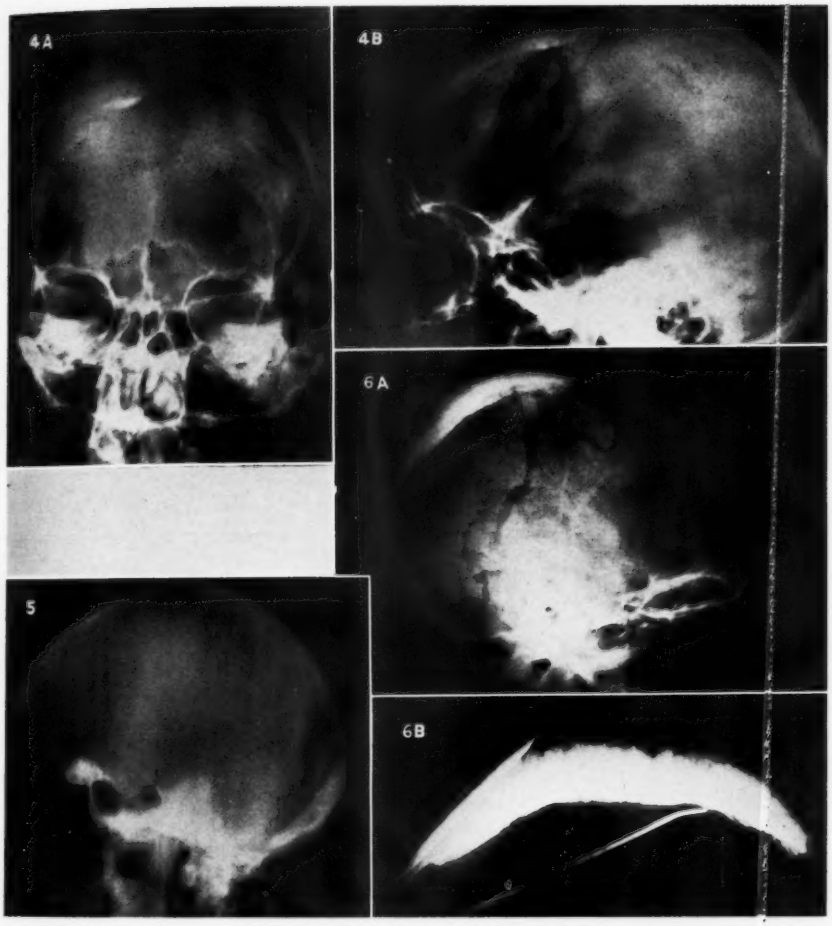


Fig. 4, A and B. Localized zone of hyperostosis in a right frontal meningioma near the midline. The lateral view shows a large vascular channel coursing toward the area of the hyperostosis.
Fig. 5. Midline laminagraphic roentgenogram showing a large localized area of hyperostosis associated with a meningioma of the olfactory groove.
Fig. 6. A. Lateral roentgenogram of skull showing spiculation type of hyperostosis in the frontoparietal region due to meningioma. Increased vascularity is seen just anterior to the zone of hyperostosis. B. Bone flap showing similar findings.

cases, is presented in Table I. Approximately 78 per cent showed one or more abnormal findings. The most frequent of these were significant localized hyperostosis, atrophy of the dorsum sellae, localized increase in vascularity, psammomatous calcification, pineal shift, and localized bone resorption. In a number of cases, multiple abnormalities were demonstrated on the plain films. Figures 4 and 5 are examples of significant localized hyperostosis. Figure 6, A shows a spiculation-type of hyperostosis and Figure 6, B similar findings in a bone flap. Figure 7 is an example of psammomatous calcification. Figure 8 demonstrates a significant increase in vascularity. Figure 9, A shows localized bone resorption and Figure 9, B similar changes in a bone flap.

It is obvious that the presence of a meningioma may be strongly suspected from the findings on the plain roentgenograms. The most common diagnostic features are localized hyperostosis, in-

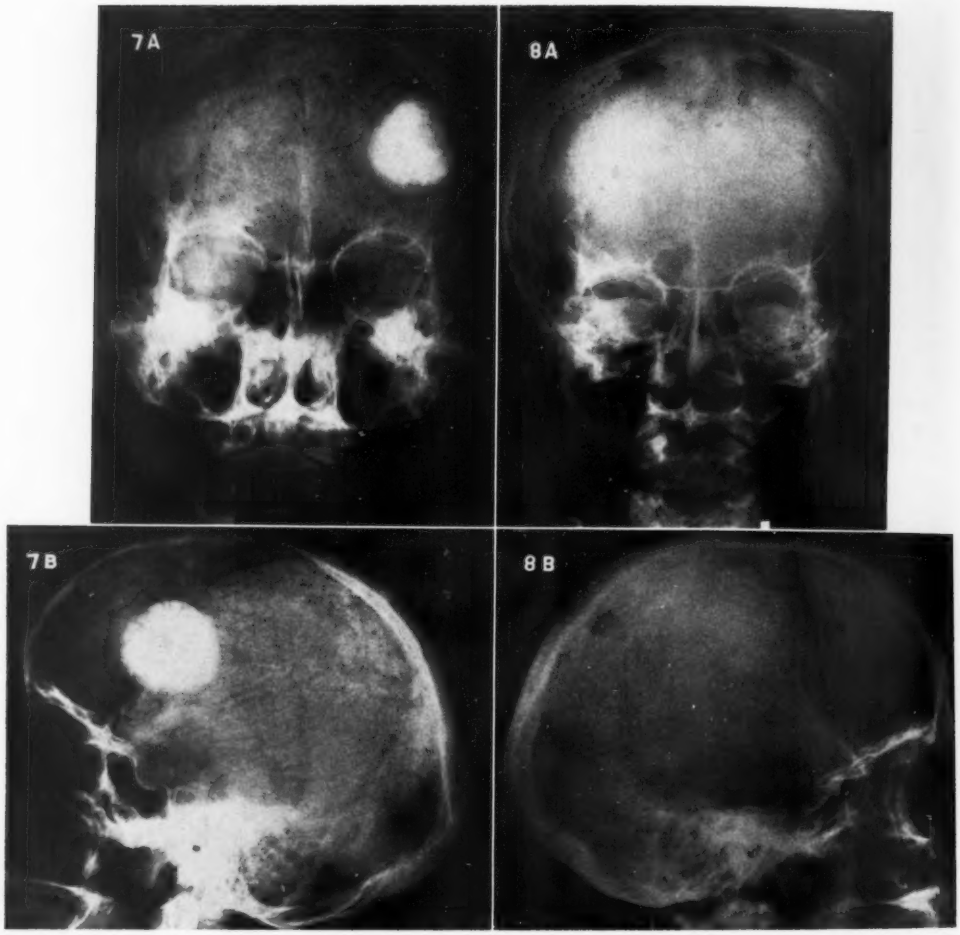


Fig. 7, A and B. Frontal plane and lateral views of skull showing a large area of psammomatous calcification corresponding to a meningioma in the left frontal region.

Fig. 8, A and B. Frontal plane and lateral skull views demonstrating a localized increase in vascularity in the left frontal area associated with a meningioma.

crease in vascularity, and psammomatous calcification. Atrophy of the dorsum sellae and a significant pineal shift are not specific for meningiomas since these abnormalities may be seen with any intracranial mass lesion. Enlargement of the foramen spinosum in the submentovertex view (because of the increase in size of the middle meningeal artery) has been reported but has not been detected in our series. Actually, the findings on the plain films may be so specific that the neurosurgeon can perform a craniotomy in certain cases without further study, *i.e.*, pneumoencephalography, ventriculography, or cerebral angiography.

Air Studies: Pneumoencephalography or ventriculography was performed in 46 of the 126 patients (mostly before 1950), revealing significantly abnormal findings in 44 (Table II). The abnormalities most commonly demonstrated were a significant shift of the septum pellucidum and/or the ventricular system and localized deformity of segments of the latter.

Figure 10 shows a shift of the ventricular system to the right of the midline and a pressure deformity of the body of the left

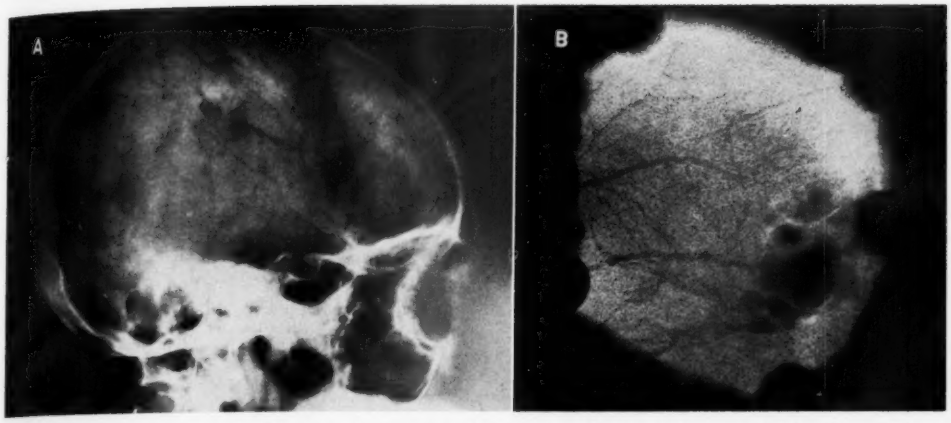


Fig. 9. A. Lateral view of the skull showing an area of bone resorption in the frontoparietal region. A large vascular channel is seen contiguous to the area of lysis. B. Bone flap showing similar changes.

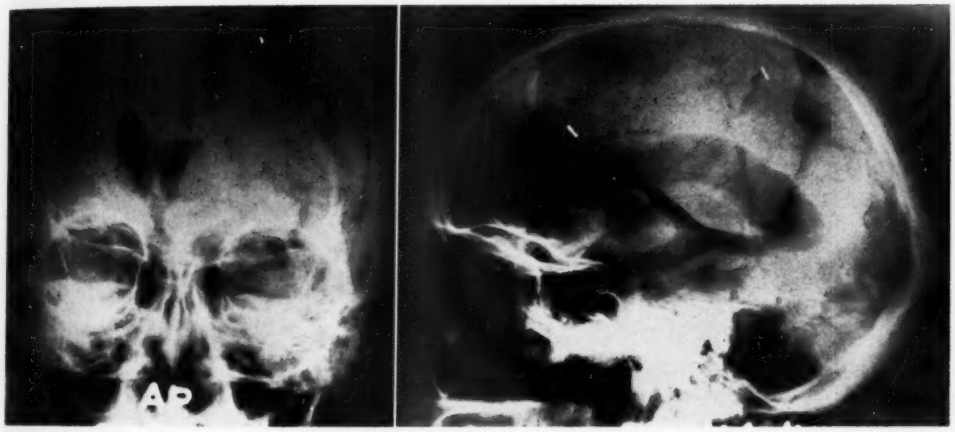


Fig. 10. Frontal plane and lateral views in air study, showing typical deformities due to a recurrent left-sided posterior frontal parasagittal meningioma. Dural clips are present from previous surgery.

lateral ventricle in a case of posterior frontal parasagittal left-sided meningioma.

An evaluation of intracranial air studies of meningiomas has been more than adequately carried out by others in the past (5). There are no characteristic findings in the air study which will lead to a definite diagnosis of meningioma except in those instances where a mass is found parasagittally, particularly in a female. In such cases, an inferential diagnosis of meningioma is reasonable. A more comprehensive and detailed analysis of the air studies performed in our cases is not felt to be practicable or necessary, since in recent years significantly fewer such examinations have been performed, particularly in our department. This chang-

TABLE II: PNEUMOGRAPHY AND/OR VENTRICULOGRAPHY

	Total	Per Cent
Number of patients with air studies	46*	
Normal air studies	2	4.3
Abnormal air studies	44†	95.7
Significant shift of septum pellucidum and/or ventricular system	36‡	81.8
Localized deformity of lateral ventricle	24‡	54.5

* Three patients had both pneumoencephalography and ventriculography.

† Percentages calculated on basis of total abnormals.

‡ Significant shift of ventricular system and localized deformity of lateral ventricle present in same patient in a number of instances.

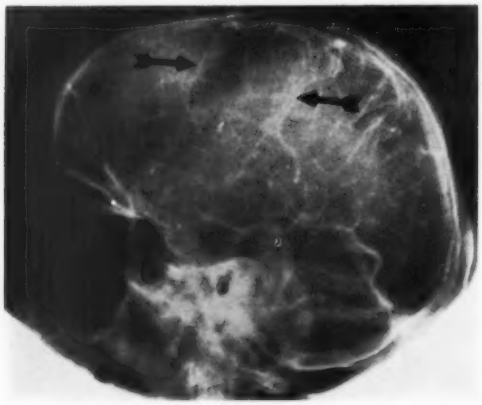


Fig. 11. Lateral view in venous phase of cerebral angiogram showing large zone of relative avascularity in the posterior frontal area (arrow) associated with a meningioma.

ing attitude is generally true for all supratentorial lesions but is particularly applicable in those instances where a meningioma is suggested by the plain films or clinically. Cerebral angiography would seem to be the initial diagnostic procedure of choice except in cases of suspected posterior fossa lesions.

Cerebral Angiography: Of the 126 cases, 43 were studied by cerebral angiography. Many were collected from the period prior to 1953 and do not accurately reflect the increasing popularity of cerebral angiography. Also, a number were diagnosed definitely on the plain films. Table III lists the findings noted on cerebral angiography which are nonspecific for meningiomas. Of the 43 cerebral angiograms,

TABLE III: NONSPECIFIC ANGIOGRAPHIC CHANGES: 43 CASES

	Total	Per Cent*
Normal cerebral angiograms	1	2.3
Abnormal cerebral angiograms	42	97.7†
Significant shift or displacement of anterior cerebral artery	27	64.3
New vessel formation at site of lesion	27	64.3
Significant shift or displacement of middle cerebral artery and/or other major vessel	26	61.9
Localized zone of avascularity	9	21.4
Circumferential vascular delineation of lesion	5	11.9

* Percentages calculated on basis of total abnormals.
† Multiple findings present in a number of patients and listed separately.

TABLE IV: SPECIFIC ANGIOGRAPHIC CHANGES: 42 CASES

	Total	Per Cent
Sharp deflections of arteries	27	64.3
External carotid artery filling	22	52.4
Classic "cloud"	18	42.9
Central arterial zone with peripheral venous drainage in tumor area	16	38.1
Beaded, varicose appearance of small arteries	15	35.7
Fine, linear, wiry arterial vessels	13	31.0
Radiolucent defects in "cloud" stain	4	9.5
Break in superior sagittal sinus	1	2.4

only 1 was normal. There was a significant displacement or shift of the anterior cerebral artery beyond the midline to the opposite side in 64 per cent of the cases and a significant shift or displacement of the middle cerebral artery and/or other major vessel (other than the anterior cerebral) in 62 per cent. New vessel formation was seen in 64 per cent of the cases. A localized zone of avascularity was present in 9 cases (21 per cent, Fig. 11). Parenthetically, we have found this sign to be helpful in the diagnosis of other intracranial mass lesions. The avascular zone is usually seen in the late arterial phase but may appear in the venous phase. Thrombosis of the intracranial portion of the carotid artery (1 case), and incorporation of the anterior or middle cerebral artery in the tumor mass (2 cases) were also noted but are not specific for meningiomas. Figure 12 shows the characteristic displacement of vessels in an extracerebral type of lesion which is highly suggestive but not specific for a meningioma. This finding, although often mentioned in the literature, has not frequently been seen in our experience.

Specific Vascular Changes in Cerebral Angiography: Utilizing Lima's descriptive classification of cerebral vascular findings in meningiomas (10) and adding our own observations, we have divided the types of specific vascular change on angiography into 8 categories. Table IV lists these and their incidence in our series. In almost two-thirds of the cases (64 per cent), the cerebral arteries were sharply deflected

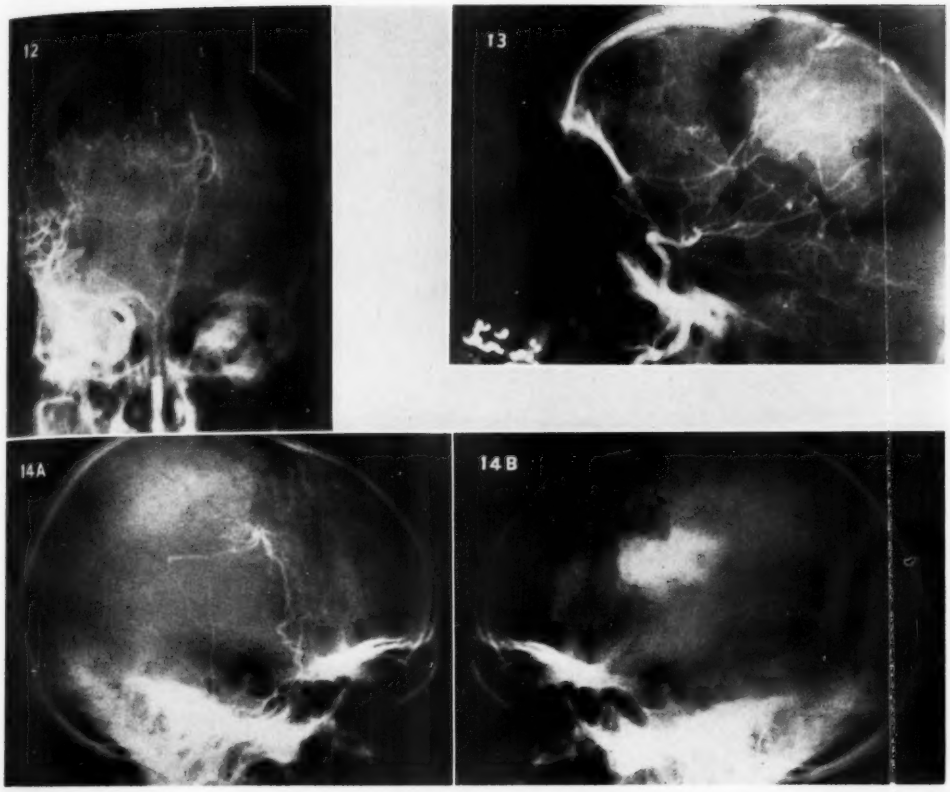


Fig. 12. Frontal plane roentgenogram in arterial phase of cerebral angiogram showing the so-called characteristic downward displacement of arteries due to a right-sided parasagittal frontal area meningioma. The right anterior cerebral artery is displaced considerably to the left.

Fig. 13. Lateral view of skull in arterial phase of cerebral angiogram demonstrating the sharp deflection of the vessels by a meningioma in the frontal area. The circumscribed nature of the lesion is apparent.

Fig. 14. A. Enlarged branches of meningeal artery supplying a meningioma in the posterior frontal region (arterial phase). Only the branches of the external carotid artery were opacified. There was no filling of the internal carotid artery. B. Later phase in same case, showing a large "cloud" at the site of the meningioma.

in the region of the tumor, connoting the well demarcated nature of this neoplasm (Fig. 13). The intracranial meningioma received its blood supply from the external carotid circulation in approximately half the cases, 52 per cent (Fig. 14). The vessels supplied in the external carotid circulation were usually the superficial temporal or middle meningeal arteries. Internal and external carotid artery filling can be differentiated only by: (*a*) observation of the initial phase of opacification of the external circulation and the relating of this opacification to vascularization of the tumor, if present; and (*b*) the actual differential filling of the external circulation by cut-down or manipulation of the needle. Slightly less than half of the patients (43 per cent) showed the classic, homogeneous, well demarcated "cloud" (Fig. 15). The "cloud" was usually noted in the late arterial phase and frequently continued through the entire venous phase. In about one-third of the cases (38 per cent) there was a central arterial circulation in the tumor area followed by peripheral venous drainage with abnormally dilated cerebral or meningeal veins (Fig. 16). On one-third of the angiograms (36 per cent) the arterial supply to the tumor showed a beaded or varicose appearance (Fig. 17). A different type of arterial

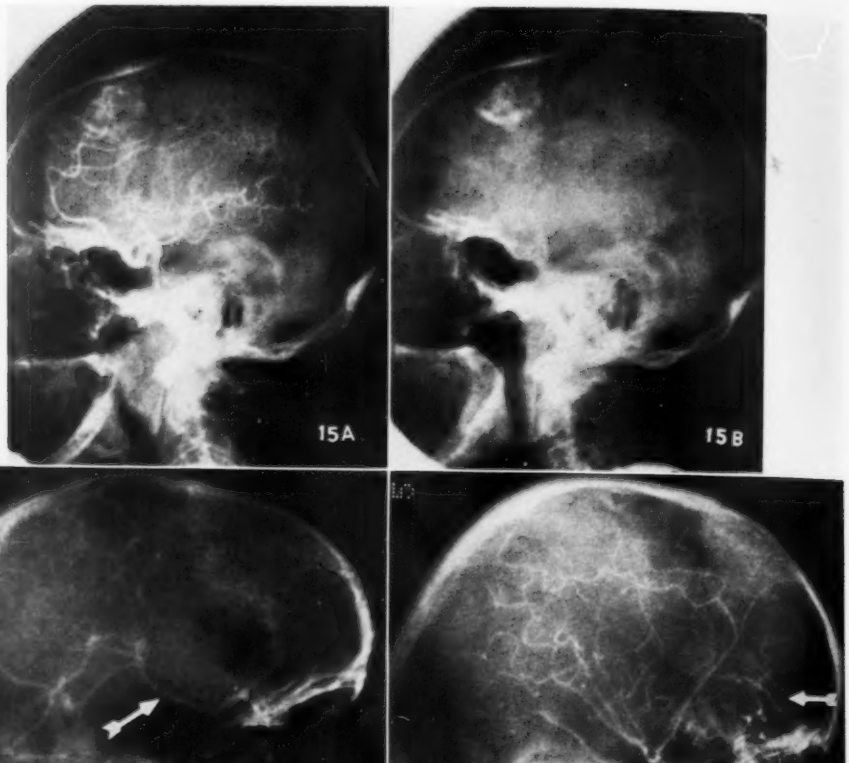


Fig. 15, A and B. Another example of the classic "cloud" seen in the arterial and late venous phases of a cerebral arteriogram in a case of a meningioma in the frontal area.

Fig. 16. Abnormally dilated cerebral veins in the venous phase of a cerebral arteriogram associated with a meningioma in the posterior frontal region (arrow).

Fig. 17. Arterial phase of cerebral angiogram, delineating a beaded, varicose appearance of the arterial supply of a meningioma low in the frontal region (arrow). Note the backward displacement of the anterior cerebral artery.

supply to the tumor was observed in another one-third of the cases (31 per cent), with fine, linear, wiry vessels noted (Fig. 18). Infrequently observed in our series were such findings as radiolucent defects in the center of the "cloud" stain (Fig. 19) and a break in the superior sagittal sinus (Fig. 20).

We have found that those cases showing an increase in vascularity on the plain films are apt to show external carotid artery filling and abnormal vessel formation in the tumor area.

We must acknowledge that in those cases of meningioma which fail to demonstrate external carotid artery vascularization and/or the classic "cloud," the appearance of the localized zone of increased vascularity supplied by the internal carotid artery may, at times, cause considerable difficulty in differential diagnosis. All of us, undoubtedly, have experienced problems in differentiating glioblastoma multiforme and metastatic lesions from meningiomas in the cerebral angiogram.

SPECIAL TECHNICS

The use of the submentovertical view to demonstrate enlargement of the foramen spinosum has been mentioned.

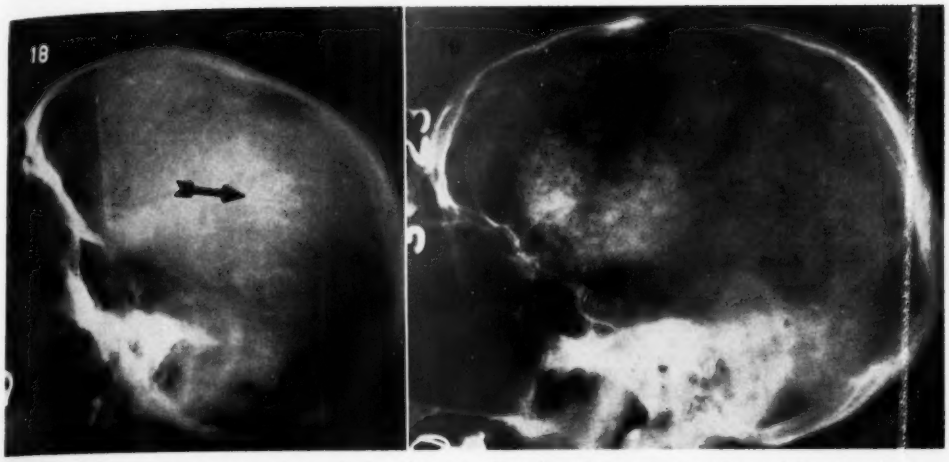


Fig. 18. The late arterial phase of a cerebral angiogram. Very fine, linear, wiry vessels supplying a meningioma (arrow).
Fig. 19. Radiolucent defects interspersed in a large "cloud" late in the venous phase of a cerebral arteriogram, due to a meningioma in frontal area.

The concept of differential filling to demonstrate external carotid artery vascularization of the tumor is important. If the initial filling does not demonstrate the external carotid artery vascularization of the tumor, then differential filling of the external carotid circulation may be carried out by manipulation of the needle or by cut-down. Figure 21 represents a case of thrombosis of the carotid artery at the siphon in a sphenoidal ridge meningioma. This serves as an excellent example of differential filling without surgical intervention. The carotid siphon is occluded and a "cloud" stain is seen arising from the external carotid circulation.

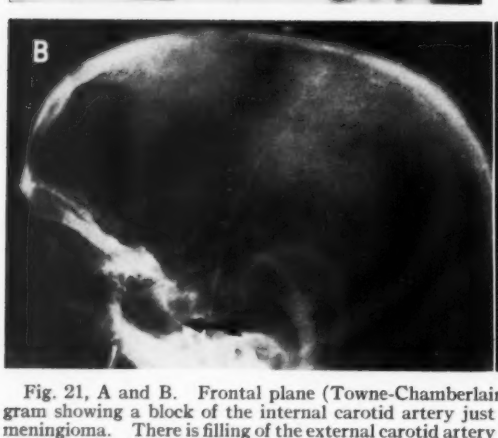
We have encountered one case of contralateral vascularization of the tumor where the anterior cerebral artery on the ipsilateral side failed to fill, but filled *via* the anterior cerebral on the opposite side and produced a tumor stain with a contralateral shift of this latter vessel.

Sinography may be important to demonstrate obstruction of the sagittal sinus, particularly in parasagittal lesions. Oblique views may be helpful in delineating occlusion of the sagittal sinus, although the lateral view may be diagnostic in the venous phase (Fig. 20) of the cerebral angiogram.

Fig. 20. Venous phase in a cerebral angiogram showing a break in the superior sagittal sinus in the posterior frontal region due to a parasagittal meningioma in this area (arrows).

SUMMARY AND CONCLUSIONS

A roentgen study of 126 cases with intracranial meningiomas has been presented. The age and sex incidence and sites of involvement have been summarized. The typical plain film findings have been il-



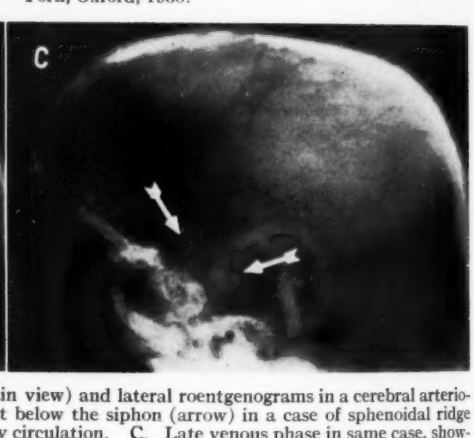


Fig. 21, A and B. Frontal plane (Towne-Chamberlain view) and lateral roentgenograms in a cerebral arteriogram showing a block of the internal carotid artery just below the siphon (arrow) in a case of sphenoidal ridge meningioma. There is filling of the external carotid artery circulation. C. Late venous phase in same case, showing a large "cloud" stain (arrows) necessarily produced by branches of the external carotid artery. This case serves as an excellent example of the differential filling referred to in the text.

lustrated. The abnormalities noted on air studies are tabulated. The recent utilization for cerebral angiography of a rapid biplane film changer using 14 × 14-inch film is described and the great advantages inherent in such a unit have been stressed. The nonspecific and specific angiographic changes in meningiomas have been tabulated and illustrated. Special technics for the diagnosis of these tumors have been discussed.

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SUMMARIO IN INTERLINGUA

Meningioma Intracranial: Un Studio Roentgenologic De 126 Casos

Es describite certe characteristic criterios roentgenographic de meningioma intracranial, vidite in 126 casos confirmate. Le resultatos de pelliculas conventional, studios a aere, e angiographia cerebral es tabulate. In iste ultime processo, un rapide excambiator de pellicula biplan, usante pelliculas de 14 per 14 pollices, esseva empleate.

Approximativemente 78 pro cento de 120 pelliculas conventional monstrava un o plure anormalitates. In un numero de casos, anormalitates multiple esseva demonstrate. Il occurre que iste constatationes es si specific que in certe casos un neurochirurgo pote effectuar craniotomia sin examine additional. Hyperostosis localisate, augmento de vascularitate, e calcification psammomatose es vidite le plus communmente.

Pneumoencephalographia o ventriculographia esseva effectuate in 46 casos, con constatationes significativemente anormal in 44. Iste deviationes esseva principalmente un notabile displaciamento del septo pellucide e/o del systema ventricular e localisate deformitates del systema ventricular.

Quaranta-tres casos de meningioma esseva studiate per angiographia cerebral. Le constatationes esseva normal in solmente 1 de iste casos. In 64 pro cento, le arterias cerebral esseva acutemente deflectite in le region del tumor. In 52 pro cento, le meningioma recipeva su provision de sanguine ab le externe circulation carotidic. In 43 pro cento, le classic, homogenee, ben demarcate "nube" esseva demonstrate. In 38 pro cento, un circulation central arterial in le area del tumor, sequite per drainage periphero-venose con anormalmente dilatate venas cerebral o meningeal, esseva demonstrate. In 36 pro cento de angiogrammas, le vasculatura arterial que alimentava le tumor presentava un apparentia perlate o varicose. Un altere typo de vasculatura alimentante le tumor esseva notate in 31 pro cento del casos. Istos se distingueva per le presentia de vasos fin e linear que habeva le apparentia de filos metallic. In le casos que exhibi un augmentate vascularitate in pelliculas conventional, on pote expectar le constatation de replenation carotidic externe e un anormal conformation vascular in le area del tumor.

Es discutite technicas special que es relationate al diagnose de meningiomas. In certe casos il es necessari utilisar le vista submento-vertical pro demonstrar un allargamento del foramine spinose. Sinographia pote demonstrar un obstruction del sino sagittal, specialmente in lesiones parasagittal. Vistas oblique pote esser utile in delinear occlusion del sino sagittal, ben que le vista lateral pote esser diagnostic in le phase venose del angiogramma cerebral.

The Significance of Bilateral Basal Ganglia Calcification

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BILATERAL basal ganglia calcification was first recognized as a histologic entity in 1855 and described independently in that year by Virchow (1) and Bamberger (2). This phenomenon was encountered postmortem by many authors during the next eighty years but was not reported as a radiographic finding until 1935, when Fritzsche (4) and then Kasanin and Crank (5) described the roentgen appearance of this specific type of intracranial calcification in living patients. Four years later, in 1939, its occurrence in idiopathic hypoparathyroidism was described by Eaton, Camp, and Love (6). Its occurrence in pseudohypoparathyroidism, another disease characterized by abnormal calcium phosphorus metabolism, was first reported in 1945 by Sprague, Haines, and Power (14). Camp re-emphasized the association with hypoparathyroidism in 1947 (18).

TABLE I: INCIDENCE OF ABNORMAL CALCIUM METABOLISM IN PATIENTS WITH BASAL GANGLIA CALCIFICATION

	No. Patients	Total Patients	Per Cent of Total	Total Per Cent
1. Abnormal calcium-phosphorus metabolism demonstrated by blood chemistry studies:				
A. Idiopathic hypoparathyroidism	42		48	
B. Postop. hypoparathyroidism	2		2	
C. Pseudohypoparathyroidism	14		16	
		58		66
2. Other diagnoses established:				
A. Familial idiopathic basal ganglia calcification	6		7	
B. Toxoplasmosis	5		6	
C. Other miscellaneous diagnoses	11		13	
		22		26
3. Diagnosis not established	8	8	8	8
TOTAL CASES		88		100

ANATOMICAL CONSIDERATIONS

The basal ganglia (Fig. 1) are masses of gray matter lying in the base of each cerebral hemisphere. They include three major structures—the caudate nucleus, the putamen, and the globus pallidus—and two minor centers—the amygdala and the claustrum. The caudate nucleus is an elongated mass of gray matter composed of a pear-shaped head, which bulges into the anterior horn of the lateral ventricle, and a slender arcuate tail, which is closely related to the atrium and temporal horn of the lateral ventricle. The putamen and globus pallidus form an oval wedge of gray matter, the lenticulate nucleus, which lies lateral to the head of the caudate nucleus. The basal ganglia are major centers of the extrapyramidal nervous system. In diseases of this system, such as parkinsonism or athetosis, they are the site of degenerative histologic lesions. It is interesting that skull films of these patients seldom display basal ganglia calcification and, conversely, only 20 per cent of patients with calcification manifest symptoms of parkinsonism or athetosis.

PATHOLOGY

The pathogenesis of basal ganglia calcification appears to consist in deposition of a colloid material in and around the finer cerebral blood vessels, with subsequent calcification of this colloid (6). Eaton, Camp, and Love presented an excellent description of these histologic changes with photomicrographs. Such calcification, of a degree insufficient to be roentgenographically demonstrable, is evi-

[1] From The Department of Radiology, University of California, School of Medicine, San Francisco, Calif. Presented at the Forty-Fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16–21, 1958. For Discussion, see p. 392.

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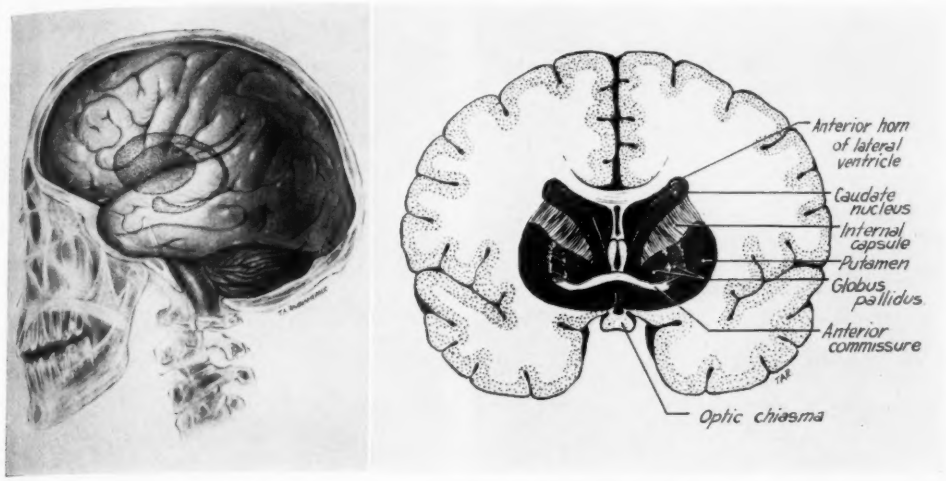

Fig. 1. Location and configuration of basal ganglia.

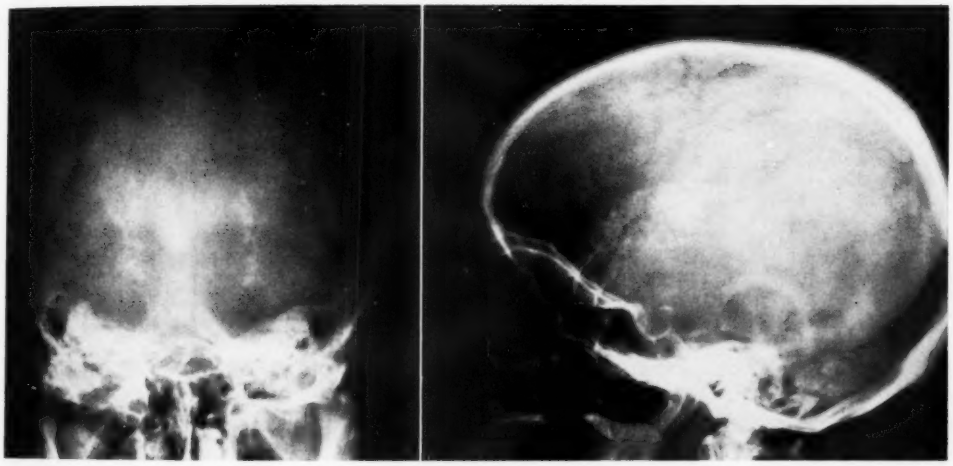

Fig. 2. Radiographic appearance of well defined, extensive basal ganglia calcification (Case II). Unfortunately many cases present less obvious calcifications.

dent histologically in about two-thirds of routine postmortem brain examinations (3,48). In the cases described in this report the range in prominence was from massive calcifications to those that were barely discernible in routine skull films.

ROENTGEN DEMONSTRATION OF BASAL GANGLIA CALCIFICATION

Basal ganglia calcifications appear as a cluster of irregular punctate densities located at a distance of 3 to 5 cm. above the sella turcica in the lateral projection of the skull, and 2 to 4 cm. lateral to the midline in the frontal and occipital projections (Fig. 2). These calcifications are almost invariably bilateral, and are usually symmetrical. Their bilateral symmetry and location greatly aid in their differentiation from other intracranial calcification, such as a partially calcified brain tumor, a vascular malformation, or postinflammatory calcification.

Basal ganglia calcifications that are just

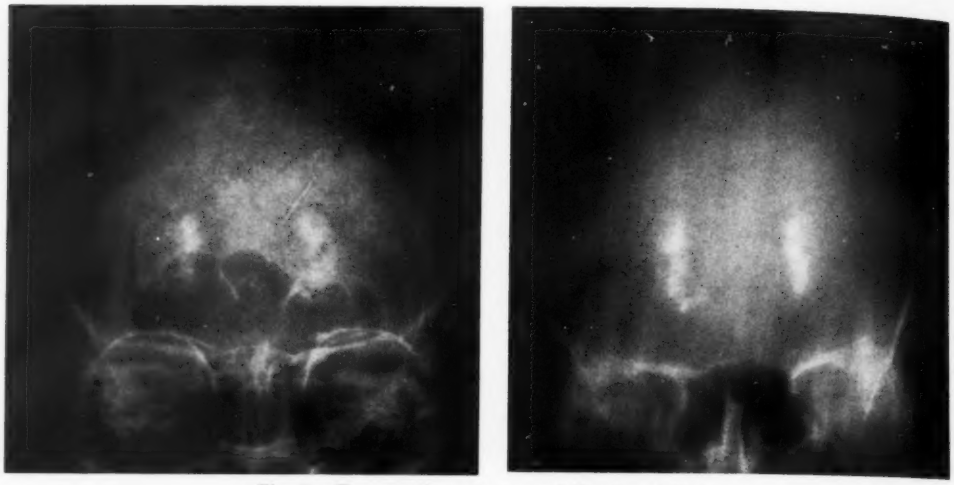

Fig. 3. Tomography enhances calcification visibility.

TABLE II: INCIDENCE OF BASAL GANGLIA CALCIFICATION

	Idiopathic Hypoparathyroidism	Pseudohypoparathyroidism
Total cases reported (1954 incl.)	103	31
Case reports mentioning skull films	75	31
Cases exhibiting basal ganglia calcification	40	14
Overall incidence	39%	45%
Corrected incidence	53%	45%

faintly visible in films of optimum detail and contrast will not be detectable in less satisfactory films. Faint calcifications also require a deliberate search of the basal ganglia area; stereoscopy in the lateral projection aids in distinguishing calcifications within the brain from the areas of increased bone density in the lateral wall of the skull. Tomography enhances the visibility of calcification (Fig. 3).

CLASSIFICATION OF CASES (Table I)

Reports of 77 cases of bilateral basal ganglia calcification have appeared in the medical literature through 1957. This report will add 10 cases studied at the University of California Medical Center, San Francisco, and 1 seen at Providence Hospital, Oakland. In this total of 88 patients, the diagnosis of a disease of abnormal calcium-phosphorus metabolism was established in 58, or 66 per cent. Forty-two patients (48 per cent of the total) had idiopathic hypoparathyroidism, 14 (16 per cent) pseudohypoparathyroidism, and 2 were post-thyroidectomy patients with surgical hypoparathyroidism. Of the remaining 30, 5 had proved toxoplasmosis in which the cerebral calcifications involved principally the basal ganglia. There were 6 cases (3 from each of two families) of familial idiopathic basal ganglia calcification and 10 of miscellaneous disease, while in 8 a definite diagnosis was not reported. The miscellaneous diseases with normal calcium-phosphorus metabolism included congenital mental deficiency, psychosis, anxiety state, hemiplegia, thyroid carcinoma, retinoblastoma, and idiopathic cerebellar atrophy. Basal ganglia calcification was an incidental finding in 1 case of head trauma. At least 4 patients of the 88 were clinically well.

Idiopathic hypoparathyroidism, surgical hypoparathyroidism, and pseudohypoparathyroidism have in common the laboratory finding of hypocalcemia with hyperphosphatemia and certain clinical manifestations which are related to this abnormality of blood chemistry. Among these latter are tetany, grand mal convulsive

TABLE III: AGE AT DIAGNOSIS

Age. (yr.)	No. Patients
0– 9	11
10–19	19
20–29	20
30–39	12
40–49	13
50–59	7
60–69	2

seizures, cataracts, mental retardation or deterioration, and such ectodermal changes as alopecia, ridging of the nails, dental dysplasia, and susceptibility to monilial infections. The term "tetany" includes carpopedal spasm, laryngeal stridor, paresthesias, muscular cramps, and weakness.

The parathyroid hormone regulates renal excretion of phosphorus. When there is an actual deficiency of the hormone, as in postsurgical hypoparathyroidism following removal or damage of the parathyroid glands, or in idiopathic hypoparathyroidism, where there is a deficiency of functioning gland substance of unknown origin, the kidneys excrete less phosphorus; the serum phosphorus therefore rises and serum calcium falls.

In pseudohypoparathyroidism there is no deficiency of parathyroid hormone but rather a diminished renal response to the hormone. The hyperphosphatemia and hypocalcemia, and related symptoms and signs, are the same, however, as in the true hormone deficiency. In addition, these patients display short metacarpals and other features suggesting a type of dyschondroplasia, and subcutaneous calcifications. The Ellsworth-Howard test demonstrates the poor renal response to an intravenous injection of parathyroid hormone.

The incidence of basal ganglia calcification is about 50 per cent in both idiopathic hypoparathyroidism and pseudohypoparathyroidism (Table II). This roentgen finding is rare in postoperative hypoparathyroidism, probably because of prompt detection and treatment of such patients.

It is not possible to distinguish between basal ganglia calcification due to abnormal calcium-phosphorus metabolism and the calcification of other diseases. In our series, 2 patients with the most extensive calcification had normal calcium-phosphorus metabolism (Cases V and X).

INCIDENCE OF CLINICAL MANIFESTATIONS

The case reports of 77 of the total 88 patients presented adequate documentation of clinical manifestations. There was no significant sex difference; 36 patients were males, 47 were females, and in 5 cases the sex was not stated. Almost half the patients were between the ages of ten and thirty at the time the diagnosis was made (Table III).

TABLE IV: INCIDENCE OF CLINICAL MANIFESTATIONS
(77 Patients with Adequate Data)

	Convulsions	Mental Retardation	Extrapyramidal Symptoms	Cataracts
Idiopathic hypoparathyroidism (35 patients)	25 (71%)	22 (63%)	7 (20%)	22 (63%)
Pseudohypoparathyroidism (14 patients)	10 (71%)	8 (57%)	1 (7%)	8 (57%)
Postoperative hypoparathyroidism (2 patients)	1	1		2
Total calcium-phosphorus abnormality (51 patients)	36 (70%)	31 (61%)	8 (16%)	32 (63%)
Other diseases (26 patients)	11 (42%)	12 (46%)	7 (27%)	3 (12%)
Overall Total (77 patients)	47 (61%)	49 (64%)	15 (20%)	35 (45%)

Some degree of mental retardation or deterioration was evident in 49 patients (64 per cent); 47 patients (61 per cent) had one or more convulsions (grand mal seizures), and 35 (45 per cent) had both mental changes and convulsions. Fifteen patients (20 per cent) exhibited symptoms resembling parkinsonism or athetosis. Tetany of some form was present in almost all cases of abnormal calcium-phosphorus metabolism and in none of the 30 others. Thirty-five patients (45 per cent) had

Fig. 4. Case I. Idiopathic hypoparathyroidism. Female, age 22 years.

cataracts, and 32 of this group had abnormal calcium-phosphorus metabolism.

Thirty-one cases of pseudohypoparathyroidism, 14 of which exhibited basal ganglia calcification, have been reported in the medical literature. Table V shows that the average age, the average duration of symptoms, and the percentage of patients more than twenty years of age, were all greater in those with calcification; the incidence of convulsions was considerably higher in this group.

TABLE V: PSEUDOHYPOPARATHYROIDISM (31 Patients)

	14 Patients With Basal Ganglia Calcification	17 Patients Without Basal Ganglia Calcification
Average age	25 years	17 years
Average duration of symptoms	19 years	13 years
Percentage of patients over age 20 years at time of diagnosis	64 %	33 %
Convulsions	71 %	44 %
Mental retardation or deterioration	57 %	68 %

CASE REPORTS

CASE I: *Idiopathic Hypoparathyroidism.* A white female was first seen at the University of California Medical Clinic at the age of 22 years, complaining of bilateral leg weakness with recurring painful cramps in the calves and spasms of the hand muscles. Childhood history revealed an illness characterized by tetany and pseudoparalysis at the age of one year, successfully treated by the addition of vitamins to the diet. Since the age of seventeen, there had been episodes of carpopedal spasm two to three times weekly.

Physical examination revealed bilateral Chvostek's and Trousseau's phenomena. The nails appeared brittle and the hair dry. Serum calcium was 7.4 mg. per 100 c.c., and serum phosphorus 5.5 mg. per 100 c.c.. An electrocardiogram revealed a prolonged Q-T interval of 40 seconds. Skull films disclosed bilateral symmetrical basal ganglia calcifications (Fig. 4). The patient responded satisfactorily to a regimen of emphojel, calcium chloride, and dihydrotachysterol.

CASE II: *Calcification of Basal Ganglia.* A 37-year-old white female gave a history of grand mal convulsive seizures occurring with increasing frequency since the age of twenty-one years and paresthesias of the extremities, increasing alopecia, and ridging of the toenails for three years. Recurrent dental caries had led to the extraction of all but five teeth. Diminution of vision was first noticed at the age of twenty-nine; bilateral cataract extraction was performed at thirty-two years.

Physical examination revealed bilateral Chvostek's and Trousseau's phenomena. Electroencephalography indicated a mild generalized convulsive susceptibility. Serum calcium was 6.2 mg. per cent; serum phosphorus 6.5 mg. per cent. Skull roentgenograms demonstrated faint calcifications bilaterally in the region of the basal ganglia.

CASE III: *Idiopathic Hypoparathyroidism.* A 10-year-old white boy had a febrile convulsion at the age of six months and approximately twenty grand mal seizures during the next nine years. Skull films were made because of intermittent frontal headaches of five weeks duration. Calcification evident in these films aroused suspicion of brain tumor.

Examination revealed a bilateral Chvostek's sign. Trousseau's sign could not be elicited. The teeth were somewhat malformed. The serum calcium was 6.2 mg. per cent and total proteins were normal. Urinalysis surprisingly showed a consistently positive Sulkowitch test, with urinary calcium ranging between 125 and 330 mg. per twenty-four-hour specimen. Skull films revealed faint stippled calcifications in the region of the basal ganglia, bilaterally. Scattered curvilinear calcifications were also faintly visible throughout both cerebral hemispheres, best demonstrated by tomography.

Idiopathic hypoparathyroidism with a low renal threshold for calcium, despite otherwise normal renal function, has been substantiated by several years of clinical observation.

CASE IV: *Idiopathic Hypoparathyroidism.* An 8-year-old white girl had been having episodes of carpopedal spasm since infancy, severe since the age of six. She exhibited bilateral Chvostek's and Trousseau's phenomena.

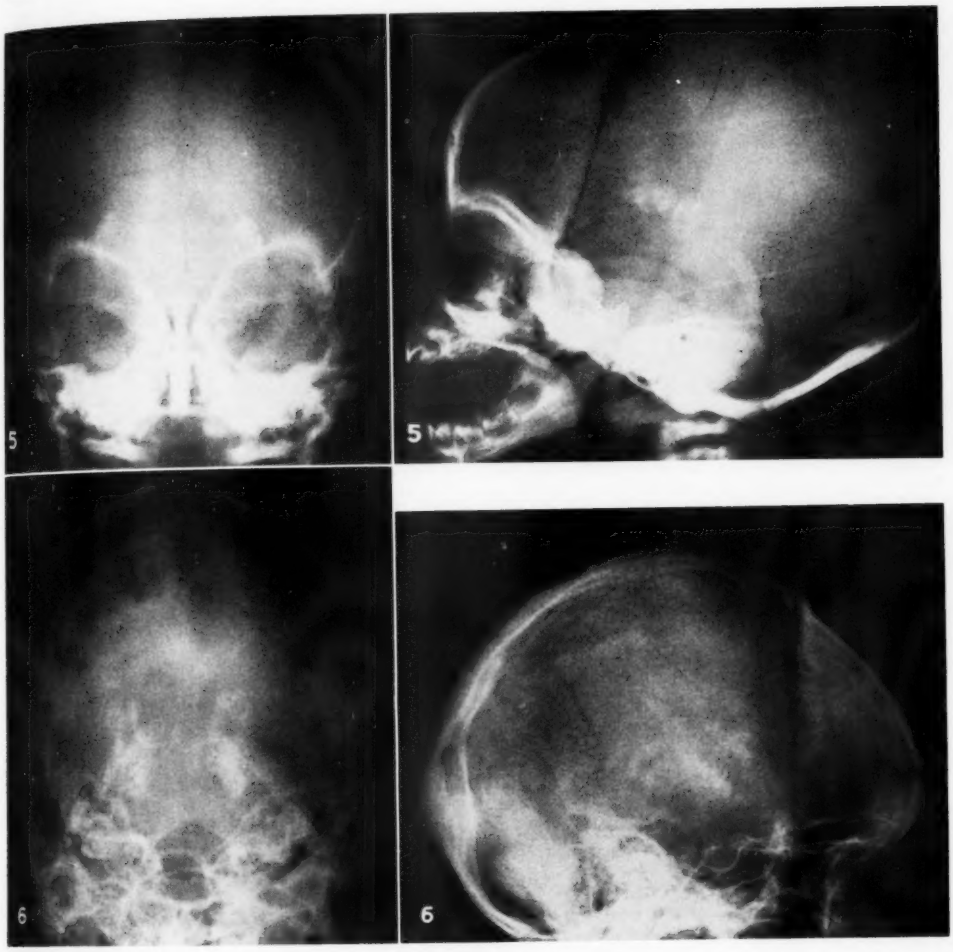

Fig. 5. Case VI. Three-week-old female with marked basal ganglia calcifications which completely disappeared during the following four months. Clinical diagnosis of cerebral palsy.
Fig. 6. Case VIII. Calcification in basal ganglia and in cerebellar cortex (and dentate nucleus?) bilaterally. Normal calcium-phosphorus metabolism.

Physical examination revealed an anterior polar cataract involving the left lens. The teeth were irregular, with obvious enamel deficiency of the incisors and canines, and there was also evidence of oral moniliasis. Serum calcium was 5.9 mg. per cent, serum phosphorus 11 mg. per cent, total proteins normal—6.4 gm. per cent. Electroencephalography indicated a generalized paroxysmal dysrhythmia of nonspecific type. The electrocardiogram showed a prolonged Q-T interval. The Ellsworth-Howard test revealed a normal response to intravenously injected parathyroid hormone. Faint bilateral basal ganglia calcifications were evident on skull films.

The patient has been controlled satisfactorily during the past nine years by medical management.

CASE V: *Idiopathic Basal Ganglia Calcification.* A 51-year-old white female was seen at the Langley Porter Clinic with a diagnosis of chronic paranoid schizophrenia with symptoms of two years duration. Routine skull films revealed extensive bilateral basal ganglia calcification (Fig. 2). There was no history of convulsions, paresthesias, muscle spasms, or extrapyramidal tract manifestations. Serum calcium and phosphorus were not abnormal.

This patient's psychosis responded well to electroshock therapy. The diagnosis was idiopathic basal ganglia calcification without evidence of abnormality of calcium-phosphorus metabolism.

CASE VI: *Transient Iatrogenic Hypercalcemia* (?). The patient was an infant born by spontaneous

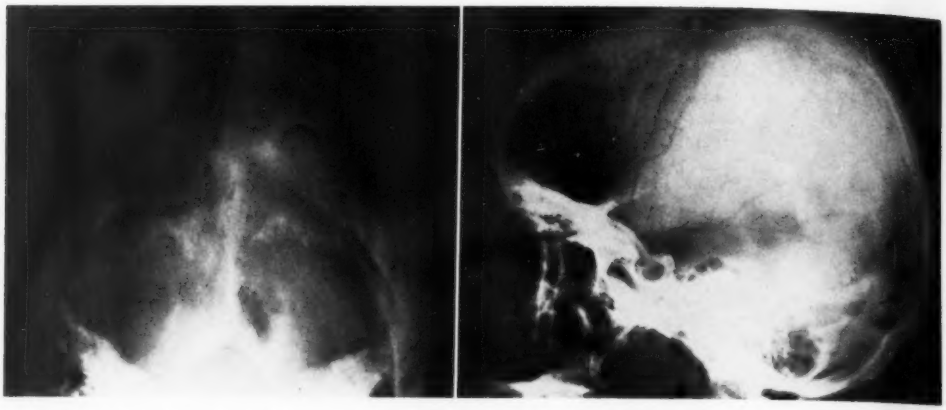

Fig. 7. Case IX. Retinoblastoma. Calcification in basal ganglia and also choroid plexus, bilaterally.

delivery, the product of a normal, full-term pregnancy. During the first day of life, a generalized tremor followed by a convulsion was noted. Lumbar puncture and fontanel aspiration revealed no abnormality of pressure or cerebrospinal fluid. Generalized muscular twitching and frequent convulsive seizures continued, despite Dilantin and barbiturate medication; there was no response to intravenous calcium. Feeding was by gavage. The family history was negative except for epilepsy in one aunt.

The infant was admitted to the University of California Hospital at the age of three weeks, with generalized tremors, slightly hyperactive reflexes, a horizontal nystagmus, and slight overriding of the cranial sutures. No chorioretinal lesions were evident on funduscopy; the optic disks were normal. Routine films of the skull showed rather extensive, bilateral symmetric calcification of the basal ganglia (Fig. 5). No other intracerebral calcifications were evident. The size of the skull suggested some degree of microcephaly. Toxoplasmosis dye fixation tests were performed on both mother and child, but were negative. There was no evidence of Rh incompatibility. Serum calcium and phosphorus determinations performed just before the infant's discharge from the hospital proved to be technically unsatisfactory. Electroencephalography revealed no abnormality. Interestingly, no convulsions occurred during the nine days of hospitalization. The tremors diminished in intensity and frequency. No treatment except reduction in barbiturate medication was instituted.

The infant was readmitted four months later, at the age of five months. There had been no convulsions during the interval. The main problem had been one of nutrition, the child taking feedings poorly. She cried for long intervals, the cry being high-pitched, occasionally relieved by enemas. She also appeared to be blind and definitely mentally retarded. She was readmitted because of a low-grade fever of undetermined origin. Examination at this time revealed a spastic quadriplegia with blindness, thought to be of cerebral cortical origin, and questionable deafness. Funduscopy was again negative. Films of the skull revealed complete disappearance of the calcifications which had been clearly evident in the previous examination. Microcephaly was again evident. Blood chemistry studies at this time showed a serum calcium of 9.4 mg. per cent, serum phosphorus 2 mg. per cent, and serum alkaline phosphatase 22 units. Total serum proteins were 5.2 mg.

Disappearance of cerebral calcification has not heretofore been reported in the literature. The cause of basal ganglia calcification initially observed in this patient remains obscure. It has been suggested that the intravenous administration of calcium in the first few days of life in an attempt to control the convulsions may have caused sudden hypercalcemia with precipitation of calcium in the basal ganglia and that this later disappeared when the patient's serum calcium level dropped to a normal range.[3]

CASE VII: *Toxoplasmosis.* A child was first seen at the age of three years with the diagnosis of cerebral palsy with mental retardation and apparent blindness. Physical examination revealed unilateral healed lesions of toxoplasmic chorioretinitis, microcephaly, spastic quadriplegia, and mental retardation. Skin tests and antibody neutralization tests for toxoplasmosis on the serum of both patient and mother were positive. Films of the skull revealed

[3] See Discussion by Dr. H. O. Peterson, p. 393.

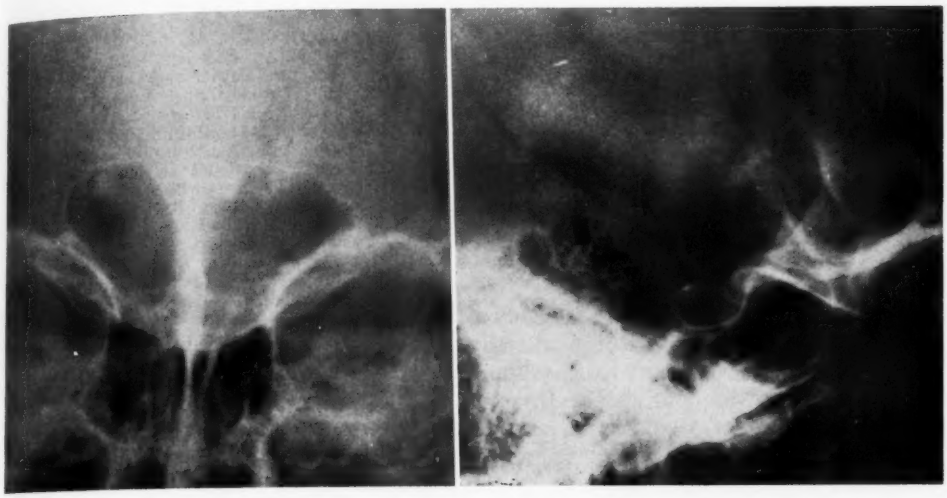

Fig. 8. Case X. Thyroid carcinoma. Incidental finding of basal ganglia calcification.

unusual bilateral, symmetric, crescentic calcifications in the region of the tail of the caudate nucleus as well as unilateral calcification in the region of the inferior portion of the head of the right caudate nucleus, and other rounded calcifications scattered throughout the left cerebral hemisphere. There was no evidence of any abnormality of calcium-phosphorus metabolism.

CASE VIII: *Degenerative Central Nervous System Disease.* A 36-year-old Chinese male was admitted, complaining of difficulty in walking, because of weakness of the left leg, and slurring of speech of one month duration.

Physical examination revealed dysarthria with scanning speech. Skull films demonstrated bilateral oval clusters of irregular calcifications of the basal ganglia and extensive cortical calcification of both cerebellar hemispheres (Fig. 6). Pneumoencephalography disclosed dilatation of the left lateral ventricle and bilateral cerebellar atrophy. Serum calcium and phosphorus examinations were normal.

The consensus was that this was an idiopathic degenerative process associated with cerebellar atrophy and calcification, and bilateral basal ganglia calcification.

CASE IX: *Idiopathic Basal Ganglia Calcification.* A woman of Mexican descent was first seen at the age of twenty-four years. A left orbital retinoblastoma had been treated by surgery and postoperative irradiation at the age of fifteen years. The chief complaints were left frontal headache with episodes of vertigo and ataxia, and two generalized convulsions.

Skull films revealed bilateral calcification in the region of the tail of the caudate nucleus (Fig. 7). Serum calcium and phosphorus studies were normal.

Fig. 9. Case XI. Prominent basal ganglia calcification, lateral projection, displaying striated pattern. No evidence of abnormal calcium-phosphorus metabolism or extrapyramidal nervous system disease.

CASE X: *Bilateral basal ganglia calcification* in this 36-year-old white female with metastatic thyroid carcinoma was an incidental finding (Fig. 8). There was no evidence of any abnormality of calcium-phosphorus metabolism. The diagnosis of thyroid carcinoma was first made at the age of twenty-four years and the patient was asymptomatic for a period of ten years before pulmonary metastases were noted.

CASE XI: A 56-year-old white female was admitted to Providence Hospital in Oakland, Calif., with severe headaches of one year duration and extreme nervousness. There was no history of convulsions or any other symptoms of abnormal calcium-phosphorus metabolism, and physical examination re-

vealed no evidence of mental deficiency or retardation, cataract, or central nervous system disease. Serum calcium was 9.5 mg. per cent; the serum phosphorus value was not obtained. Films of the skull revealed rather extensive calcification of the basal ganglia bilaterally. The patient was discharged with the diagnosis of chronic anxiety state, with the incidental finding of "idiopathic nonfamilial basal ganglia calcification in a patient with normal calcium-phosphorus metabolism."[4]

SUMMARY

The detection of basal ganglia calcification in roentgenograms of the skull may lead to the diagnosis of idiopathic hypoparathyroidism or pseudohypoparathyroidism. Two-thirds of 88 patients presenting this finding had such a metabolic abnormality. Approximately half of the patients with either idiopathic hypoparathyroidism or pseudohypoparathyroidism have basal ganglia calcification. Mental deterioration, convulsions, and cataracts seem to be more frequent and more severe as the duration of uncorrected hypocalcemia and hyperphosphatemia increases. An understanding of the significance of basal ganglia calcification may lead to early diagnosis and treatment of an atypical case, thus preventing late, irreversible changes. Statistics suggest, however, that by the time this calcification is visible these late features of idiopathic hypoparathyroidism and pseudohypoparathyroidism are also likely to be present. In one-third of the patients, basal ganglia calcification is of undetermined significance.

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SUMMARIO IN INTERLINGUA

Le Signification De Calcification Bilateral Del Gangliones Basal

Le detection de calcification del gangliones basal in roentgenogrammas cranial pote resultar in le diagnose de idiopathic hypoparathyroidismo o pseudohypoparathyroidismo. Duo tertios de 88 patientes con ille constatation roentgenographic habeva le mentionate typo de anormalitate metabolic. Approximativemente un medietate del patientes con idiopathic hypoparathyroidismo o con idiopathic pseudohypoparathyroidismo ha calcification del gangliones basal. Il pare que deterioration mental, convulsiones, e cataractas deveni plus sever e plus frequente con le aggravation de non-corrigite hypocalcemia e hyperphosphatemia. Le comprension del signification de calcification del gangliones basal pote resultar in le precoce diagnose e tractamento de casos atypic e prevenir tardive e irreversibile alterationes. Tamen, le analyse statistic del datos disponibile pare indicar que al tempore quando iste calcification ha devenite visibile, le mentionate tardive aspectos de idiopathic hypoparathyroidismo e pseudohypoparathyroidismo es etiam presente con un alte grado de probabilitate. In un tertio del patientes, calcification del gangliones basal es un interessante constatation de indeterminate signification.

The Systematic Use of Tomography in the Diagnosis of Carcinoma of the Paranasal Sinuses[1]

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ADVOCACY OF THE use of routine tomography in patients suspected of harboring malignant tumors of the paranasal sinuses is not new. In 1944 Holvey (4) recommended the method as a means of better delineating the extent of tumors of the maxillary antra, and subsequently Dargent and his associates (2) in 1948 and Leroux-Robert and Ennuyer (5) and Baclesse (1) in 1951 and 1952 cited it as an indispensable aid in the diagnosis and treatment planning of such tumors. The current work is an extension of studies begun in 1948 by Dr. Gilbert H. Fletcher, who employed the basic technic then in use at the Curie Foundation.

To date, we have examined 123 patients with primary tumors of the ethmoid, maxillary, or sphenoid sinuses. No malignant frontal lesion has been encountered. In each instance conventional radiographic projections were supplemented by tomograms. It is the purpose of this paper to cite briefly the incidence, clinical findings, and natural history of these tumors as they relate to the roentgen examination, stressing the need for and advantages of tomographic studies. The differential diagnosis of secondary and primary neoplasms will also be considered.

INCIDENCE AND SYMPTOMATOLOGY

At the M. D. Anderson Hospital and Tumor Institute the percentage distribution of cancer of the paranasal sinuses is 0.7 per cent, as contrasted with an average of eight sources quoted by Wille (8) which places the figure at 1.6 per cent of the general cancer population. Since all these estimates are largely based upon cancer center statistics, the community level incidence of 0.2 per cent of the general cancer population (6) is more pertinent to the present discussion. If this rate is applied to the current population of the United States, at least 800 to 1,000 new cases may be expected yearly. While comparatively low, this incidence is sufficient to warrant a renewed awareness of the disease on the part of all physicians. That such a need exists has been well documented by Wille's series of 220 patients, 131 of whom were treated symptomatically for two to six months and 47 for six to twenty-four months before proper definitive therapy was undertaken.

The average age of our patients was 55.6 years, with the tumors occurring twice as frequently in males as in females (83 males, 40 females). There was no significant variation in the age of onset for squamous-cell carcinoma as opposed to adenocarcinoma. The average age for tumors of non-epithelial origin was 50 years. The youngest patient in the squamous-cell-adenocarcinoma group was 13 years of age, the oldest 86 years. Eight patients (7.5 per cent) were less than 40, and a like number were over 75.

The clinical picture varied somewhat, depending upon the location and extent of the individual tumor, but many initial complaints were common to all varieties. The commonest presenting symptoms, in order of frequency, are as follows:

1.	Unilateral nasal obstruction	60 times
2.	Unilateral nasal discharge (purulent to hemorrhagic)	43 times
3.	Swelling of cheek	39 times
4.	Exophthalmos, epiphora, and impairment of vision	37 times
5.	Face, jaw, eye, or nose pain	28 times
6.	Alveolar ridge or palatine mass	19 times

[1] From the Department of Radiology, The University of Texas, M. D. Anderson Hospital and Tumor Institute, Houston, Texas. Presented at the Forty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16–21, 1958.

HISTOLOGY	ANTRUM–INFRASTRUCTURE				ANTRUM–SUPERSTRUCTURE				ANTRUM–DIFFUSE		ANTRUM–MEDIAL WALL		ETHMOIDO–MAXILLARY		ETHMOID	SPHENOID	TOTAL
	Laterally		Medially		Orbital Surface		Laterally										
Type	a	a?	b	b?	c	c?	d	d?	e	e?	f	f?	g	g?			
Number Cases SQUAMOUS CELL CARCINOMA	5	9	7	4	7	11	5	3	4	3	2		18	8	3	1	90
ADENOCARCINOMA	1	1		1		2	1	1		1	1		3	3	1		16
FIBROSARCOMA			2		1						2				1		6
CHRONDROSARCOMA											1				1		2
OSTEOGENIC SARCOMA							1										1
RETICULUM CELL SARCOMA										1	1						2
PLASMOCYTOMA		1															1
ESTHESIONEURO-EPITHELIOMA													1	1			2
MIXED TUMOR													1				1
UNCLASSIFIED (Suggest Ewing's)						1											1
MYXOFIBROSARCOMA										1							1
TOTAL	6	11	9	5	8	14	7	4	4	6	7		23	12	6	1	123

No. Classified as to Origin – 71 Cases. "x" – Two Year Follow-up, Alive. ● – Five Year Follow-up, Alive.
No. Unclassified as to Origin – 52 Cases. "o" – Two Year Follow-up, Dead. ★ – Five Year Follow-up, Dead.

TABLE I: PRIMARY PARANASAL SINUS CANCERS: HISTOLOGY AND LOCATION

7. Alveolar ridge or palatine ulcer . . . 16 times
8. Swelling of inner canthus and/or nose . . . 16 times
9. Anesthesia or hyperesthesias of 2nd division of trigeminal nerve . . . . 10 times
10. Fistula and/or skin ulcer . . . . . 6 times

With the exception of the two most common complaints, the tabulated symptoms invariably indicated invasion of the bony walls of the involved sinus, with spread beyond its confines. It is noteworthy that in only one case was the chief complaint a mass in the neck.

PATHOLOGY AND CLASSIFICATION

The majority of malignant paranasal sinus tumors arise in the maxillary antra. Ethmoid neoplasms are relatively infrequent and primary malignant disease of the sphenoid and frontal sinuses is extremely rare. DeLorimier (3) estimates that approximately 85 per cent of these growths occur in the maxillary antra and 10 per cent in the ethmoid sinus, with frontal and sphenoid lesions accounting for perhaps 2 per cent.

The material comprising our series shows a moderately different distribution, possibly as a result of the advanced status of the disease in many patients. Eighty-one (66 per cent) were classifiable as tumors of maxillary origin, 6 (5 per cent) as ethmoid lesions. By contrast, 35 (28 per cent) were designated as ethmoido-maxillary, since the extent of the disease precluded identification of the point of origin. Only 1 case of sphenoid sinus carcinoma was encountered, and this was questionable, since the presence of ethmoid disease suggested a possible origin in the posterior ethmoid cells.

Although the sinus chambers normally are lined with ciliated columnar epithelium, the majority of tumors are moderately differentiated squamous-cell carcinomas resulting from squamous metaplasia. Of the 123 primary neoplasms, 73 per cent were squamous carcinomas, 13 per cent adenocarcinomas, and 14 per cent sarcomas, mixed tumors, etc. A review of the histopathologic sections on all cases with questionable diagnoses has been

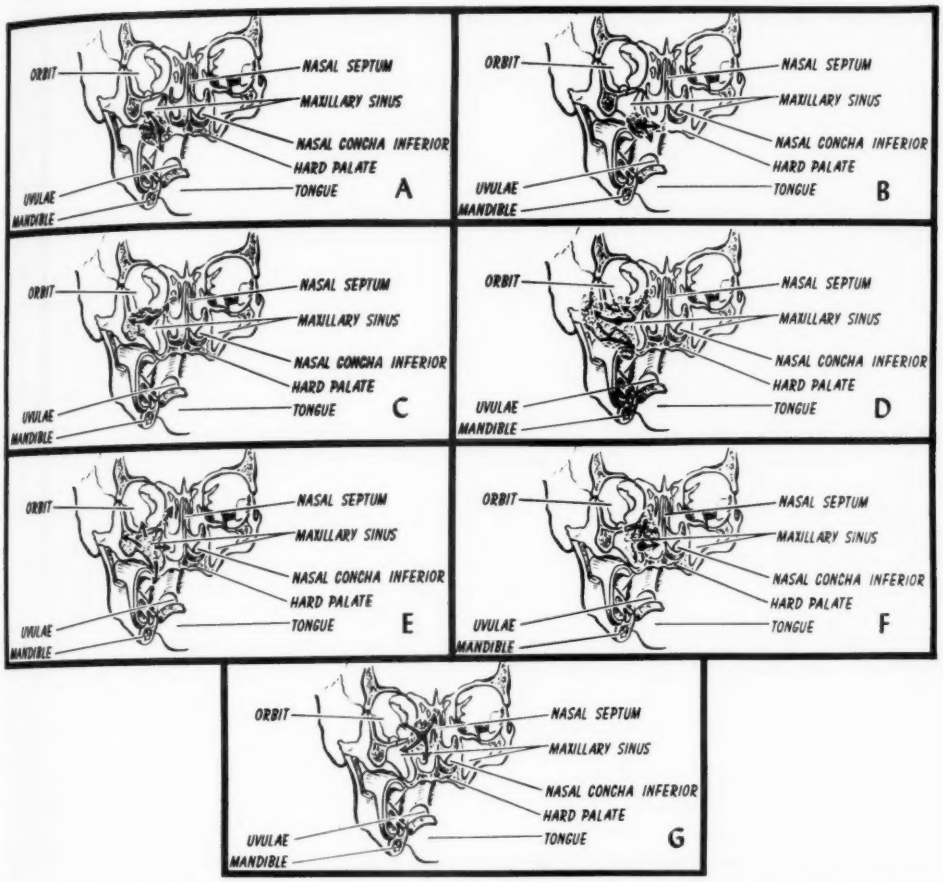


Fig. 1. A tomographic classification of cancers of the maxillary antra and ethomoido-maxillary region. Stippled areas indicate points of origin; arrows routes of spread (after Baclesse).

possible with the single exception of the unclassified tumor, which was not available for restudy. Table I lists the variety of histologic types encountered, as well as the total number of each. From the standpoint of therapeutic procedures, tumors which originate in the maxilla itself, *i.e.*, osteogenic sarcoma, fibrosarcoma, etc., should not be considered as sinus chamber tumors *per se*, but rather as tumors of bone.

Neoplasms of the maxillary antra are usually divided into those arising in the infrastructure or lower half and those arising in the suprastructure or upper half. The majority develop in the infrastructure and have potentially a better prognosis, since growth can proceed for a longer period of time before invasion of deeper tissues occurs. In actual practice this classification has proved too broad, since it does not indicate the different sites at which tumors may originate in the supra- and infrastructures. In the earlier stages each site has a characteristic route of spread which influences the plan and outcome of treatment. For this reason, a more practical approach is the following precise topographic classification of Baclesse, based upon tomographic findings:

A. Malignant Tumors of the Maxillary Antra
   1. Neoplasms of the Infrastructure (Fig. 1, A and B). These tumors arise in the inferior recess of the sinus and extend as follows:
      (*a*) Outwardly toward the antero-external

wall of the sinus and upward toward the malar apophysis. This is the more frequent variety (Fig. 1, A).

(*b*) Medially, to infiltrate the hard palate and inferomedial wall of the sinus (Fig. 1, B).

2. Neoplasms of the Suprastructure (Figs. 1, C and D)

(*a*) Tumors arising from the sinus aspect of the orbital floor (superior wall of the sinus). Extension toward the posterior base of the internal angle or ethmoido-maxillary region is common (Fig. 1, C).

(*b*) Tumors arising in the supero-external angle of the sinus (malar apophysis) with outward propagation toward the temporal fossa and floor of the orbit (Fig. 1, D).

3. Neoplasms of the Endosinus (Fig. 1, E)
Tumors involving the major part of the sinus mucosa without spread beyond the bony walls initially. With further evolution the tumor extends outwardly in all directions, with uniform expansion and subsequent destruction of the wall at various points.

4. Neoplasms of the Medial Wall (Fig. 1, G)
Tumors arising from the antronasal septum. These are uncommon, often of mesenchymal origin, and may be considered as tumors of the nasal fossa.

5. Neoplasms of the Ethmoido-Maxillary Region (Fig. 1, F)
Tumors developing in the superior and internal portion of the sinus at the point of juncture with the ethmoid cells. These lesions are productive of early nasal, ocular, and maxillary symptoms.

B. Malignant Tumors of the Ethmoid Cells

1. Neoplasms arising in the anterior cells with extension forward into the frontonasal angle.

2. Neoplasms arising in the central cells with extension into the nasal fossa. These may be difficult to differentiate from nasal primaries.

3. Neoplasms arising in the posterior cells with extension into the sphenoid bone and sinus and into the vault of the nasopharynx.

Obviously this classification is superior to one based solely upon physical findings, since it is not possible to explore clinically all areas involved by ethmoido-maxillary tumors. Similarly, a comprehensive classification established by surgical exploration entails a form of radical therapy which is not necessarily the best suited to the individual patient. The Baclesse grouping is artificial in the sense that these tumors are seldom confined to a single area at the time of diagnosis. However, it does afford a better understanding of the natural history of the disease and therefore some indication as to the most suitable form of therapy and the prognosis. We have attempted a retrospective classification of our series of tumors, employing the surgical findings for purposes of verification whenever possible. Many of the lesions were at least moderately advanced at the time of initial examination and yet conclusions as to the points of origin could be reached and the history of the individual tumors reconstructed. The data are summarized in Table I.

Lymphatic metastases in cancer of the paranasal sinuses occur more frequently than is commonly recognized. The primary drainage route is posteriorly to the retropharyngeal group of nodes and thence to the deep jugular chain, usually at the carotid angle. Metastasis to the submental or submandibular nodes occurs only after invasion of the orbits or buccal cavity, and these in turn drain into the subdigastric group (8). The incidence of lymphatic metastases as reported in the literature ranges from 17.5 per cent to 48.9 per cent. In this series of cases, 22 (18 per cent) patients on admission had clinically positive unilateral cervical lymph node metastases and 5 (4 per cent) bilateral cervical metastases. Only one had detectable nodes in the supraclavicular region. The wide variations in incidence are not surprising, since the primary metastatic nodes lie deep within the carotid triangle and may be easily overlooked on routine palpation of the neck. This is particularly true when the submental or submandibular chains are not involved.

Blood-borne metastases are unusual. Pulmonary metastases occurred in 2 patients, liver metastases in 1, and intracranial metastases in 2, in addition to local spread of the disease.

RADIOGRAPHIC TECHNIC

The radiographic examination at the M. D. Anderson Hospital comprises Caldwell,

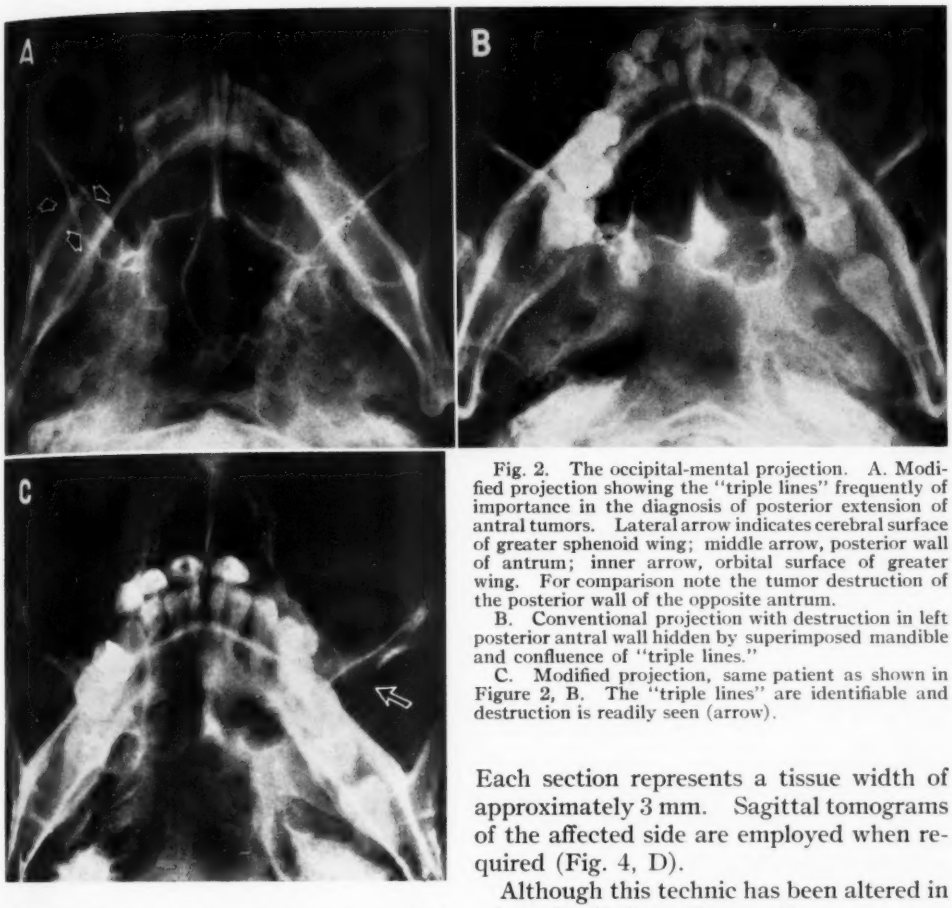


Fig. 2. The occipital-mental projection. A. Modified projection showing the "triple lines" frequently of importance in the diagnosis of posterior extension of antral tumors. Lateral arrow indicates cerebral surface of greater sphenoid wing; middle arrow, posterior wall of antrum; inner arrow, orbital surface of greater wing. For comparison note the tumor destruction of the posterior wall of the opposite antrum.

B. Conventional projection with destruction in left posterior antral wall hidden by superimposed mandible and confluence of "triple lines."

C. Modified projection, same patient as shown in Figure 2, B. The "triple lines" are identifiable and destruction is readily seen (arrow).

Waters, lateral, and two mento-vertical views of the paranasal sinuses with the use of a Potter-Bucky diaphragm and small cones. It is important to note that reliance upon the conventional Hirtz projection of the basilar structures can be productive of error. Of fundamental importance in the detection of tumors of the paranasal sinuses is a modified mento-vertical view in which the angle of the central ray is increased cephalically, resulting in clearer delineation of the posterior and medial maxillary walls and the ethmoid cells (Fig. 2).

Tomographic studies are performed with the patient prone, a total of 8 coronal sections being made from 2 to 9 cm. above the table-top. The area thus covered extends from the anterior maxillary wall to the posterior margin of the sphenoid sinus. Each section represents a tissue width of approximately 3 mm. Sagittal tomograms of the affected side are employed when required (Fig. 4, D).

Although this technic has been altered in minor details from time to time over a period of ten years, the basic elements have been maintained, and we feel that the present examination is applicable to the majority of patients and affords maximum coverage of the areas in question. Since relatively minor technical deficiencies can easily contribute to interpretive errors in this region, it is essential that all films be checked prior to the patient's leaving the department.

ROENTGEN DIAGNOSIS

The roentgen evidences of tumors in the paranasal sinuses are: opacification of the sinus, alteration in bone density (decreased density, loss of bone, increased density), and a soft-tissue mass adjacent but extrinsic to the sinus.

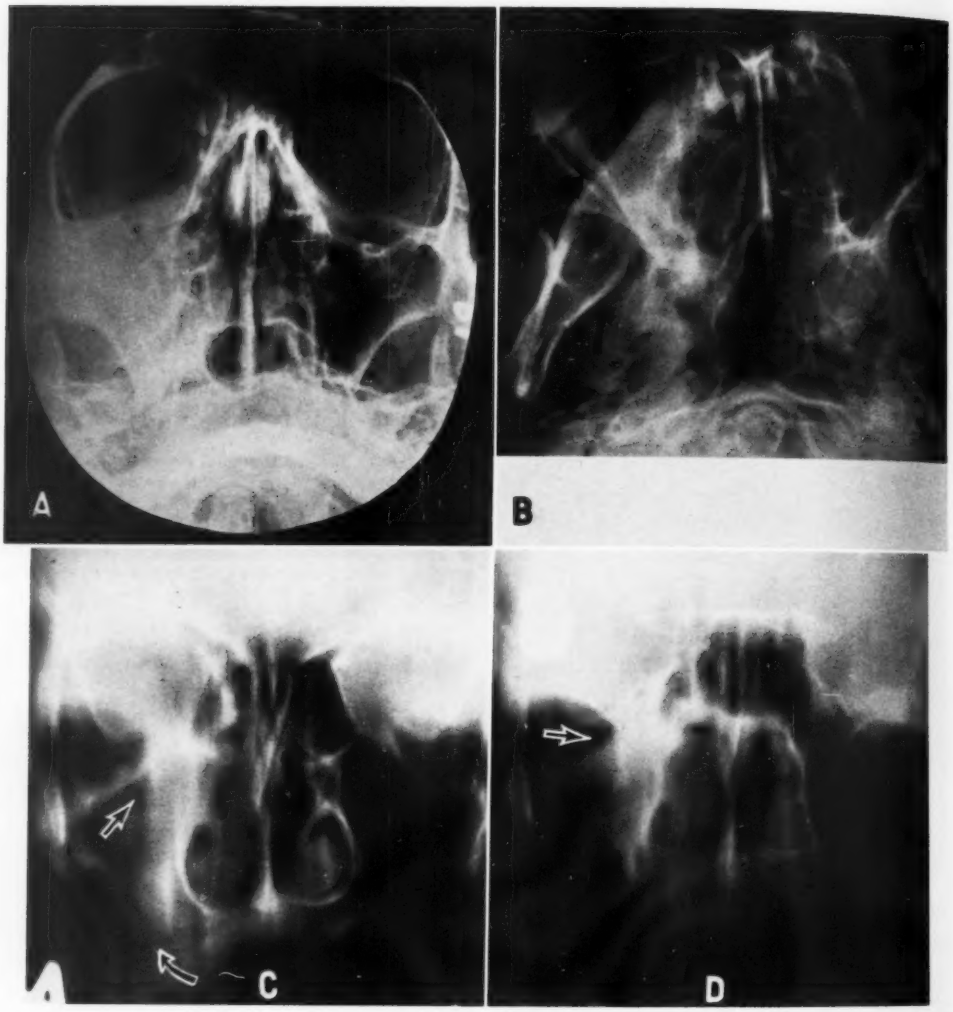


Fig. 3. Primary squamous-cell carcinoma of right maxillary sinus. A. Unilateral opacification of antrum without identifiable bone destruction. B. Marked periostitis of posterior antral wall and pterygopalatine fossa (arrows). The picture is one of chronic sinusitis. C. Coronal tomogram showing infrastructural mass and destruction of inferior wall of sinus. Note periostitis of floor of orbit (arrow). D. Tomographic verification of pterygoid plate sclerosis.

Early detection of tumors is hampered by the nonspecificity of findings other than bone destruction. Sinus opacification may result from tumor, inflammatory disease, or both. Since neoplastic disease frequently blocks the ostia of involved and adjacent sinuses, superimposed sinusitis is common and the picture may be confusing clinically as well as roentgenographically. A feature which should suggest the possibility of neoplasm is persistent opacification of one sinus or unilateral opacification of several chambers (Figs. 3, A; 6, A; 7, A). With attention thus focused, early bone destruction may be recognized by "fading" or "speckling" of a sinus wall.

Decreased density of bone may be due to tumor, inflammatory disease, or loss of contrast as a result of increased density of adjacent soft tissue. Actual absence or de-

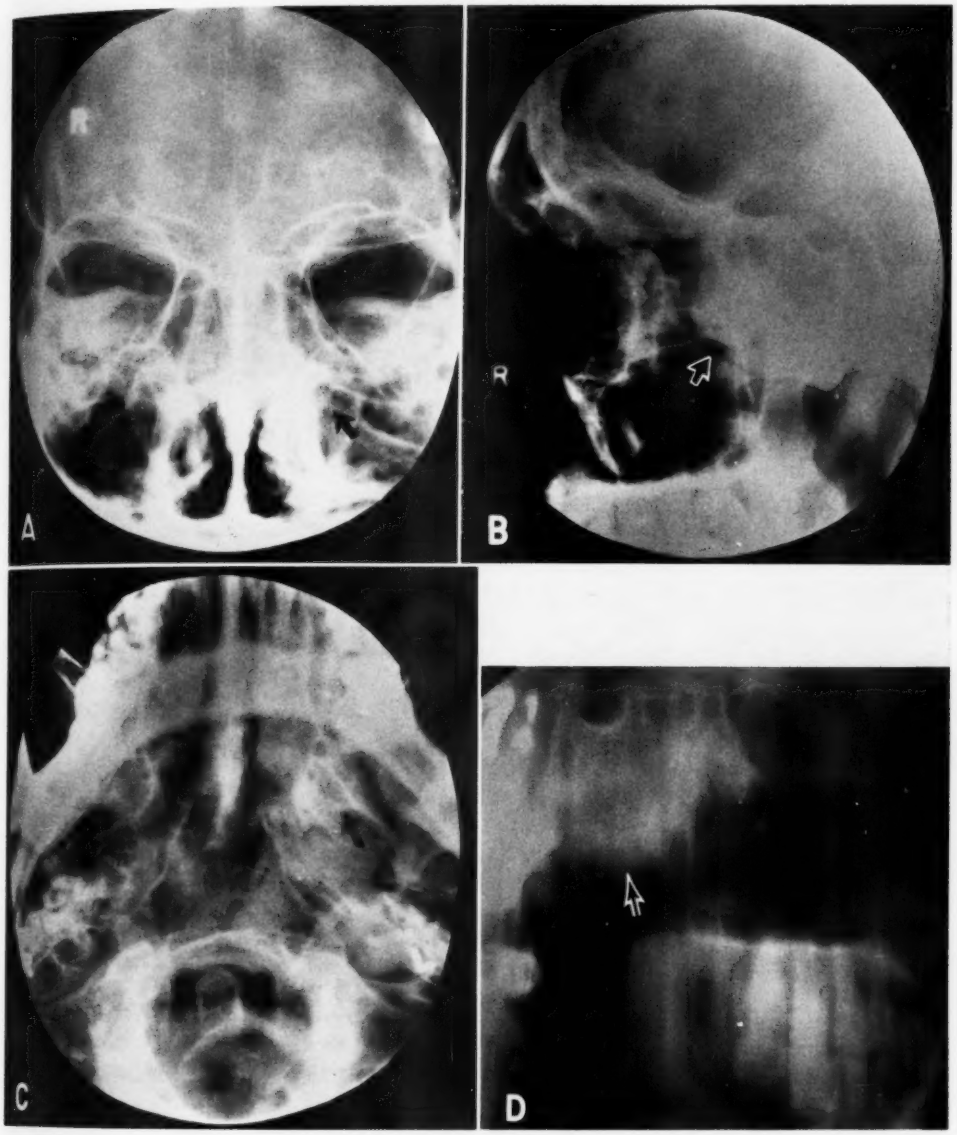


Fig. 4. Primary squamous carcinoma of posterior ethmoid cells. A. Nonspecific clouding of ethmoid and frontal cells. No bone destruction is demonstrable. B. Clouding of sphenoid sinus and apparent sclerosis of floor of middle fossa. C. Increased density noted in Figure 4, B is due to periostitis of vomer and left pterygoid plates (arrows). The left ethmoid cells are opaque and there is questionable osteolytic disease in the basisphenoid and middle fossa. D. Midline sagittal tomogram confirming destruction in basisphenoid.

struction of bone is fairly reliable evidence of neoplasm.

Increase in bone density results from osteoblastic reaction to invasion by tumor and/or from periostitis secondary to chronic infection. In the maxillary area, osteoblastic reaction to tumor is relatively rare and infectious periostitis common. The latter is frequently more pronounced on the side of malignant disease, even though bilateral inflammatory disease is present. This is best demonstrated in the posterior

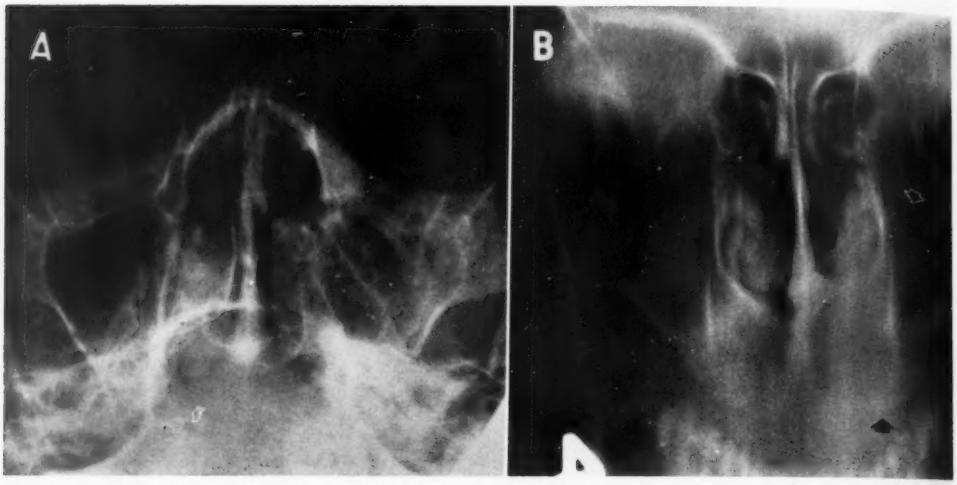


Fig. 5. Infected fibrous cyst of maxilla. History and clinical findings are compatible with diagnosis of carcinoma of antrum. A. Mass destroying medial wall and projecting beyond confines of left maxillary antrum. B. Coronal tomogram showing expansile lesion with well demarcated bony capsule. There is no true bone destruction.

maxillary wall and the pterygopalatine fossa and presumably stems from long standing sinusitis which has preceded or resulted from the tumor (Fig. 3, B, C, and D).

The middle and posterior ethmoid neoplasms are occasionally associated with an osteoblastic reaction, particularly in the vomer and sphenoid bones. It is questionable whether this results primarily from the tumor or associated infection, but, regardless of the mechanism of the osteoblastic reaction, a coexistent osteolytic process usually indicates the presence of neoplasm (Fig. 4). Anterior ethmoid neoplasms are commonly osteolytic, but, due to the thinness of the individual septa, bone destruction is difficult to recognize on either conventional films or tomograms.

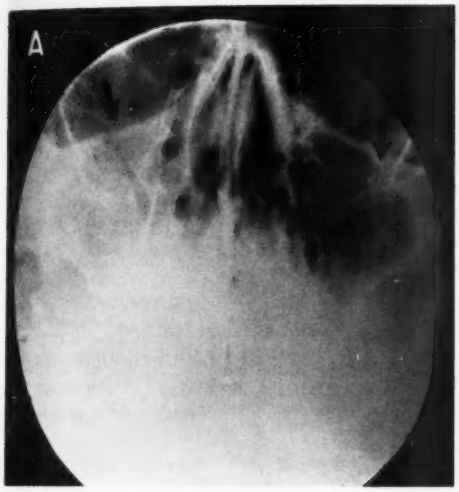
A soft-tissue mass extending beyond the sinus chamber may lead to recognition of "hidden" destruction of a wall when a careful search of all films is made. Such a mass is fairly reliable evidence of tumor, although it can be simulated by mucocele or pyocele (Fig. 5).

Assuming that a tumor is suspected clinically or radiographically, the radiologist's responsibility does not end with the demonstration of unequivocal bone invasion. The extent of the tumor must be determined so that an intelligent plan of treatment may be developed and some estimate of prognosis made. Signs of invasion of the floor of the orbit, posterior wall of the antrum, pterygopalatine fossa, or middle fossa of the skull should be carefully sought. There is no one view which will supply all information, but the base projection is often the most informative and the most neglected.

With these points in mind, the advantages of tomography become obvious. While the gross margins of a tumor may be determined to some extent by conventional films, tomographic sections provide more easily obtainable and precise information. Minimal bone destruction is frequently masked on conventional films by surrounding or superimposed intact bone, particularly in the orbital floor (Fig. 6) and inferior wall and recess of the maxillary sinus (Fig. 3). Conversely, appreciable thickening of the lining membrane of a sinus may result in apparent bone destruction, since the density of the bony sinus wall may be less than or equal to that of the adjacent soft-tissue mass. This problem is particularly troublesome in the ethmoido-maxillary region, where the thinness and obliquity of

the medial wall of the antrum often makes its demonstration difficult in the normal subject (7) (Fig. 7). Tomography at right angles to the plane of the ethmoidomaxillary septum may be most helpful in such instances.

Following surgical excision of tumors, tomograms should always be made as a base line for the detection of recurrent carcinoma. Without benefit of studies done in the immediate postoperative phase it has proved almost impossible to distinguish operative defects from those caused by recurrent cancer.



DIFFERENTIAL DIAGNOSIS

The differential diagnosis of primary tumors of the paranasal sinuses consists chiefly in distinguishing them from (*a*) inflammatory lesions, and (*b*) metastatic cancer, usually the result of direct spread of adjacent tumors. Inflammatory disease only rarely causes bone destruction; if this is present, biopsy is required to establish the correct diagnosis.

Secondary invasion by an adjacent neoplasm, if extensive when first seen, may be impossible to recognize radiographically as such. Occasionally the point of origin may be determined from the relative positions of the soft-tissue mass and bone destruction, but this is at best inexact and subject to interpretive error (Fig. 8). Lesions which commonly cause confusion are carcinomas of the skin of the nose, cheek, and eye with inward penetration; primary carcinomas of the nasal cavity with secondary invasion of the ethmoids and maxillary antra; carcinoma of the nasopharynx with spread to the ethmoid

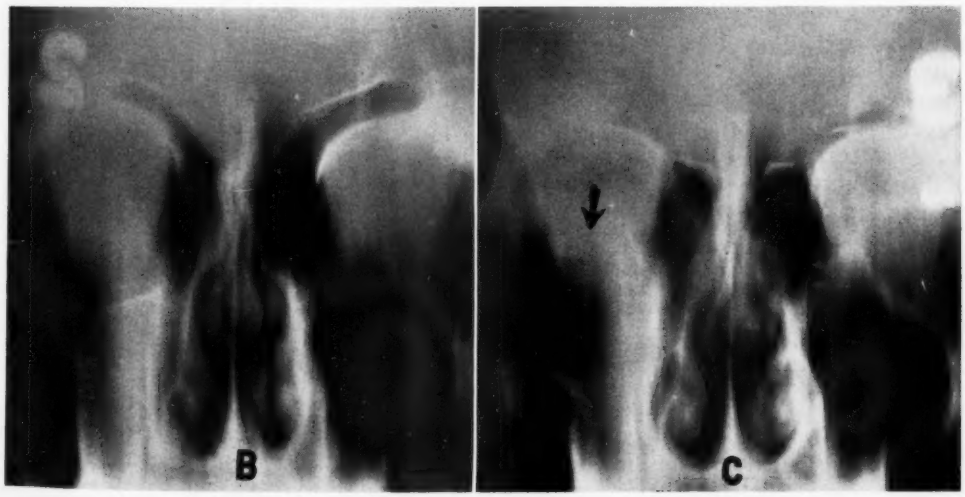


Fig. 6. Primary carcinoma of right maxillary sinus. A. Opacification of right antrum, with absence of infraorbital canal (arrow). The orbital floor is apparently intact otherwise. B. Coronal tomogram at 2-cm. level, showing well defined orbital floors bilaterally. C. Tomogram at 3-cm. level. There is extensive destruction of the suprastructure, largely masked on other projections by the superimposed intact bone.

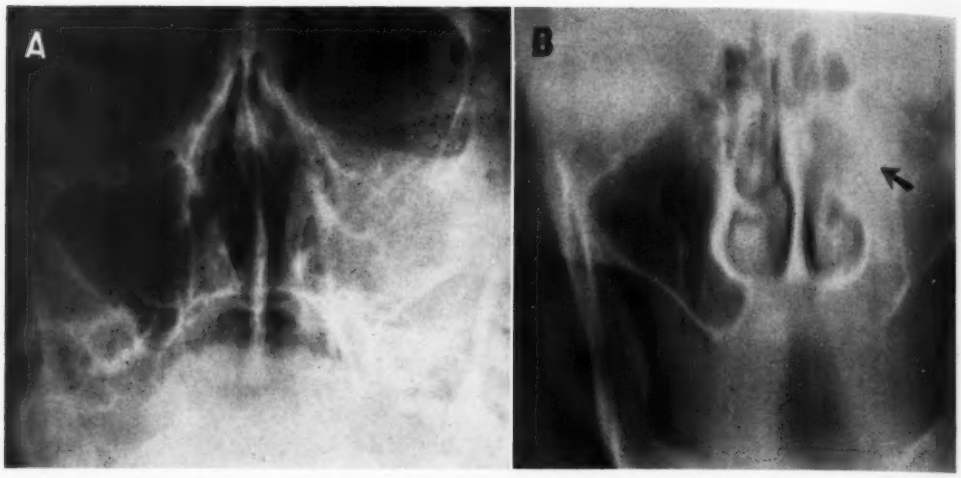


Fig. 7. Primary squamous carcinoma, left maxillary antrum. A. Standard Waters projection. The presence or absence of bone destruction in medial antral wall cannot be determined. B. Coronal tomogram at 6-cm. level, showing apparent destruction of ethmoido-maxillary septum (arrow) and inferior recess. At surgery the medial wall was intact. The interpretive error stems from obliteration of normal bone density by thickened membranes.

and sphenoid sinus, and lesions of the oral cavity with involvement of the maxillary antra. Blood-borne metastases are relatively uncommon.

Sixty-eight secondary tumors of the paranasal sinuses have incidentally been reviewed in conjunction with the primary neoplasms. Their primary sites and relative numbers are summarized in Table II. With the exception of those arising in the nasopharynx, all involved the maxillary or ethmoid cells and were, in general, indistinguishable radiographically from primary neoplastic disease. Particularly troublesome are tumors arising in the roof of the oral cavity, many of which are impossible to distinguish from primary sinus tumors clinically, radiographically, and histologically (Fig. 8). The majority of these lesions are conveniently identified as tumors of the infrastructure and treated as such. Those listed in Table II were sufficiently distinctive to permit a conclusion as to the primary site.

An interesting feature of both the primary and secondary neoplasms is a tendency to propagate along the perineural sheaths and fiber bundles of the regional nerves. In the case of antral lesions, spread usually occurs along the infraorbital nerve. This may be detected radiographically by expansion or destruction of the walls of the infraorbital canal. The incidence of this type of metastasis cannot be estimated at the present time, since it has only recently been recognized. To date, however, histologic proof has been obtained in 3 primary lesions of the maxillary antra and in numerous cases of basal- and squamous-cell carcinoma of the skin. Widening of the infraorbital canal or destruction of the floor of the orbit has been demonstrated

TABLE II: SECONDARY CANCER OF THE PARANASAL SINUSES

Primary Site			Number
I.	Invasion by Direct Spread		
	A. Tumors of the skin		61
	B. Tumors of the oral cavity		14
	1. Gum or alveolar ridge	8	
	2. Buccal mucosa	2	
	3. Hard palate	3	
	4. Soft palate	1	
	C. Tumors of the nasopharynx		5
	D. Tumors of the nasal fossa		2
	E. Miscellaneous		6
	TOTAL		63
II.	Blood Borne Metastases		
	A. Kidney		2
	B. Larynx		1
	C. Breast		1
	D. Retroperitoneal neuroblastoma		1
	TOTAL		5
GRAND TOTAL			68

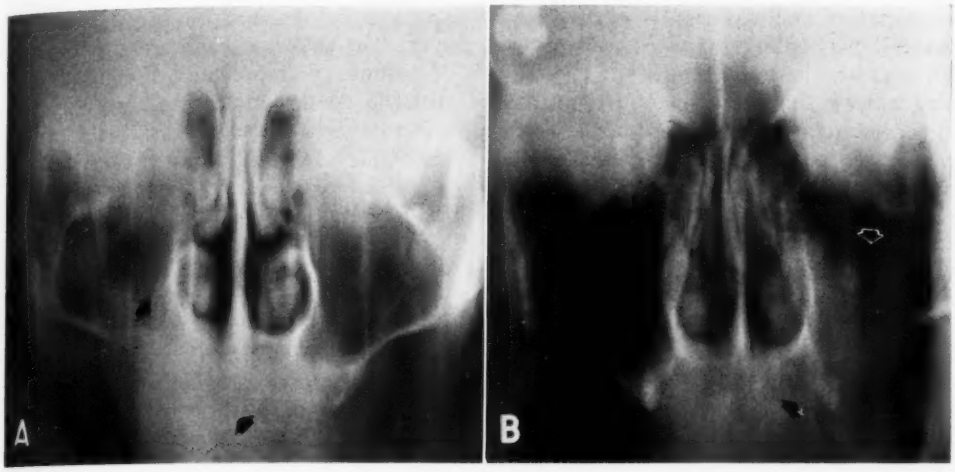


Fig. 8. Two cases of primary carcinoma of hard palate with secondary invasion of maxillary antra. A. Bulk of soft-tissue mass (arrows) and destruction extrinsic to sinus. Hard palate primary lesion probable. B. Greater part of mass and destruction in sinus; radiographically thought to represent primary antral tumor. The relative positions of mass and bone destruction are not reliable indicators of primary site.

by means of tomography on two occasions and subsequently confirmed at surgery (Fig. 9). Disease had reached the gasserian ganglion in both cases. In neither instance was the presence of disease suspected on the conventional examination.

THERAPY

It is not the purpose of this presentation to outline a therapeutic régime for cancer of the paranasal sinuses. The following figures are quoted to underline the number of treatment failures and the need for earlier diagnosis and treatment. Only 40 of our 123 patients were subject to a five-year follow-up, and no rigid treatment policy was followed. Surgery, surgery followed by irradiation, irradiation followed by surgery, and irradiation alone were employed. Of the 40 patients, 9 have survived five years or more free of disease, a 22.5 per cent salvage rate. This approximates the average in the literature.

Eighty-seven patients are available for a two-year follow-up, and these are recorded in Table I. The two-year survival of 35.6 per cent is probably of no greater significance since the overall therapeutic approach was unchanged. In this latter group the two-year survival rate for squamous-cell carcinoma was 25 per cent, for adenocarcinoma 58 per cent, and for miscellaneous cell types 67 per cent.

DISCUSSION

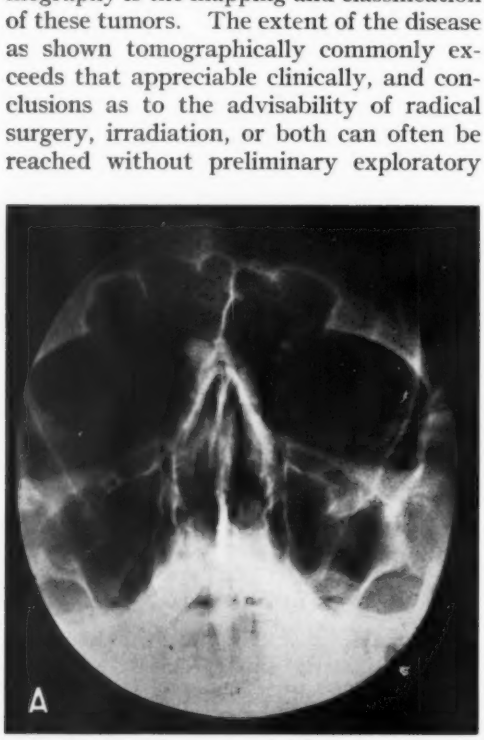
The majority of malignant tumors of the paranasal sinuses are indolent by nature. Unfortunately, the initial symptoms are vague and the more disturbing complaints may not develop until extensive invasion of bone, lymphatics, or regional nerves has occurred. The delay is often compounded by physicians or dentists, particularly when superimposed inflammatory disease responds transiently to symptomatic therapy. It does not seem unreasonable, therefore, to recommend that any patient with symptoms which do not respond rapidly and adequately to the usual medications be subjected to roentgen examination. If the findings are normal but the symptoms persist, the patient should be re-examined at frequent intervals or submit to operative visualization and biopsy. This routine is especially applicable to the person over forty with no antecedent history of sinus disease.

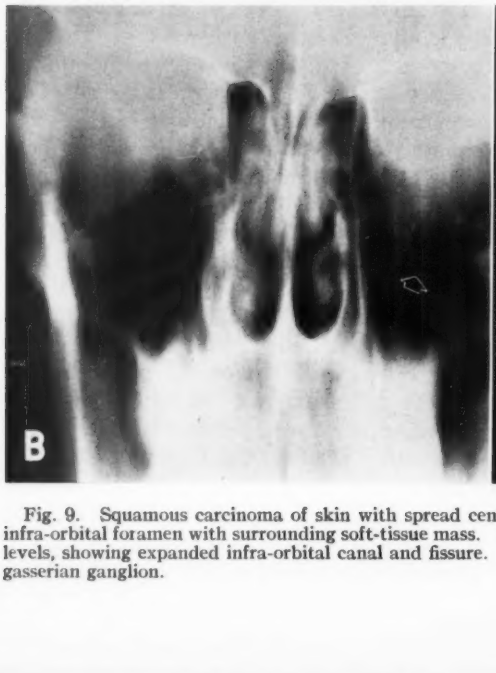
Although tomography is recommended as an aid in the early diagnosis of these lesions, few patients are referred for roentgen

examination at a sufficiently early date to make it particularly useful in this respect. At present, the most important use of tomography is the mapping and classification of these tumors. The extent of the disease as shown tomographically commonly exceeds that appreciable clinically, and conclusions as to the advisability of radical surgery, irradiation, or both can often be reached without preliminary exploratory procedures. It must be emphasized, however, that the topography of the disease is of secondary importance if clinically detectable node metastases are present. Even in early and easily classifiable lesions the value of a well planned and executed therapeutic procedure may be negated by the presence of unsuspected retropharyngeal node metastases.

In general, it can be stated that identification of tumor in the posterior wall of the maxillary antrum, the pterygopalatine fossa, or the floor of the middle fossa offers a very poor prognosis. Surgery and irradiation are at best palliative in this group. While the efficacy of surgery *versus* irradiation in early to moderately advanced disease of the ethmoido-maxillary area remains in question, current trends are toward a full course of irradiation followed by surgery for removal of accessible residual tumor.

The poor results in the treatment of these tumors, then, are mainly attributable to (*a*) late diagnosis and (*b*) improper assessment of the extent of disease, with subsequent inadequate or poorly planned therapy. Although tomography is subject to the limitations noted above, it is our belief





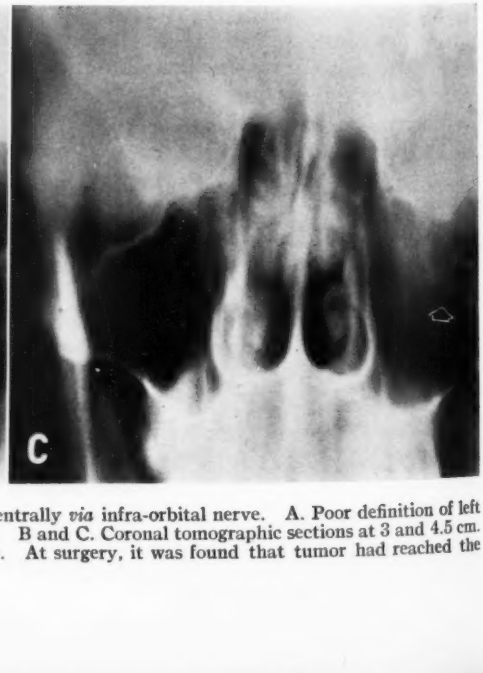


Fig. 9. Squamous carcinoma of skin with spread centrally *via* infra-orbital nerve. A. Poor definition of left infra-orbital foramen with surrounding soft-tissue mass. B and C. Coronal tomographic sections at 3 and 4.5 cm. levels, showing expanded infra-orbital canal and fissure. At surgery, it was found that tumor had reached the gasserian ganglion.

that its routine use in the sinus-tumor suspect will increase current survival rates.

SUMMARY

The roentgen diagnosis of primary or secondary malignant cancer of the paranasal sinuses depends upon the demonstration of bone destruction. Bone production, opacification of the chamber, or intraluminal mass are not in themselves specific and cannot be relied upon. Experiences with 191 patients suffering from primary or secondary malignant growths of the paranasal sinuses have led us to place great dependence upon the tomographic studies in the diagnosis and management of these lesions. While the conventional sinus projections suffice for diagnostic purposes in the typical far advanced case, minimal bone destruction may be partially or completely masked by superimposed intact bone. In these latter instances tomography is essential for proper diagnosis. In either case, the tomographic examination provides reliable information as to the extent of the disease, a factor of great importance in the formulation of an adequate treatment plan.

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SUMMARIO IN INTERLINGUA

Le Uso Systematic De Tomographia In Le Diagnose De Carcinoma Del Sinos Paranasal

Le diagnose roentgenologic de carcinoma del sinos paranasal depende del demonstration de destruction de osso. Si iste destruction es minimal, il occurre que illo es mascate, in roentgenogrammas conventional, per le intacte osso circum- e superjacente. Signos que indica le presentia de tumor es opacification del sino, alteration del densitate ossee, e un massa de histo molle, adjacente a sed foras del sino. Tumores primari debe esser differentiate ab lesiones inflammatori e ab cancere metastatic. Morbo inflammatori resulta solmente in rar casos in destruction de osso, sed quando isto occurre, biopsia es requirite pro establir le correcte diagnose. Invasion secundari per un neoplasma adjacente es a vices impossibile a recognoscer radiographicamente si illo es extense al tempore de su prime observation.

Le serie discutite in le presente articulo include 123 tumores primari del sinos ethmoide, maxillari, o sphenoide e 68 tumores secundari. Studios tomographic esseva executate con le patiente in decubito ventral. Un total de 8 sectiones coronal esseva facite ab 2 usque a 9 cm supra le platta del tabula. Le area assi coperite va ab le pariete antero-maxillari usque al margine posterior del sino sphenoide. Tomogrammas sagittal del latere afficite esseva empleate in tanto que requirite.

Infelicemente le symptomas initial de cancere paranasal es vage, e pauc patientes es presentate satis precocemente pro render le tomographia vermente utile ab le puncto de vista diagnostic. Le application particular de tomographia al tempore presente servi le delineation e classification de iste tumores post que lor presentia ha essite recognoscite. Lor extension debe

esser determinate a fin que un plano intelligente de tractamento pote esser elaborate e a fin que un estimation del prognose pote esser tentate. Signos indicante un invasion del fundo orbital, del pariete antero-antral, del fossa pterygopalatin, o del fossa centro-cranial debe esser persequite multo meticulosemente.

Post le excision chirurgic, studios tomographic debe esser facite routinarimente durante le phase immediatemente postoperatori, proque plus tarde il es quasi impossibile distinguer defectos operatori ab recurrentias de cancere.

Metastases lymphatic occurre plus frequentemente que lo que es generalmente recognoscite, sed metastases transferite via le sanguine es rar. In le presente serie, 22 del patientes (18 pro cento) habeva clinicamente positive metastases unilateral a nodos lymphatic. Cinque (4 pro cento) habeva bilateral metastases cervical. Esseva constatate 2 metastases pulmonar, 1 hepatic, e 2 intracranial.

DISCUSSION

(Papers by Maurice L. Silver et al.; Bruce N. Kvernland et al.; Robert L. Tucker et al.; Harold G. Jacobson et al.; John C. Bennett et al.; Gerald D. Dodd et al.)

Harold O. Peterson, M.D. (Minneapolis, Minn.): When I was asked whether I would discuss this group of papers, I believe that I accepted a bit too readily, thinking it an easy assignment. However, the more I studied them the more difficult it became. The notes which I have made are much too voluminous. Consequently, I shall try to condense my remarks.

During my resident days in radiology, my professor told me his philosophy of discussing a paper. He said that if you search hard enough in any paper, no matter how poor it may be, you will always be able to find something good. You should mention that first and then go ahead and tear the rest of the paper apart.

I have been critically reviewing these papers during the past couple of weeks and I find many things to tear apart. Before discussing the individual contributions, I would like to say that if anyone thinks my discussion harsh and unwarranted, he should consider the source. I am not an authority on most of the subjects and the mere fact that I accepted this assignment doesn't mean that I know a great deal about them.

I would like to start with the last paper and point out that Dr. Dodd and his associates have had a tremendous experience with carcinoma of the paranasal sinuses. The figures indicate that there are a thousand new cases a year in the United States. That means that every radiologist in the country will average one such case every four or five years, which will not give him much experience. Therefore, we should pay attention to what Dr. Dodd says, since he is discussing over a hundred cases.

It still appears to me, however, that we are not going to do very well in recognizing carcinoma of the sinuses early and I think that Dr. Dodd feels somewhat the same way. As far as tomography is concerned, I have somewhat the same feeling that I originally had; namely, an expensive way to make poor pictures. At least that has been my experience with a small number of these cases examined by tomography. However, every now and then a good study is obtained and changes not otherwise visible are observed. As a rule, I prefer the verticosubmental view and continue to stress its use routinely, particularly to demonstrate posterior extension of carcinoma of the maxillary sinus. As these tumors extend posteriorly into the pterygoid area and the base of the middle cranial fossa they become inoperable. If tomography will help in this determination, it will be a valuable additional study.

The two papers on "Intracranial Meningiomas" review large series of cases, and again this is something that most of us do not have a chance to do. I feel, however, that the greatest value of these papers will accrue to the men who did the work. They have learned a lot from their careful study which will not help the rest of us a great deal.

In their statistics I find a very high incidence of positive findings on plain films, but I believe, quite frankly, that this represents excellence with the "retrospectoscope." When you carefully study a group of proved cases of anything, it becomes much easier to recognize minor changes. If you look at these findings prior to operation or autopsy you may have to hedge quite a bit. I have made errors in diagnosis in pretty nearly every type of meningioma, but the most serious are those positive diagnoses leading to operation when no significant lesion is present.

Dr. Jacobson brought up one point of which I was not aware, namely, the thin vessels observed on angiography in some meningiomas. This is probably an accurate observation, although on one of his slides it was not very well shown.

I was surprised that only four of the rather large group of meningiomas of the tuberculum sellae, reported by Dr. Tucker, showed calcification within the lesions

I am sure that the careful study that these men have given to a large number of meningiomas has helped them a great deal and will be very beneficial to future patients coming to their institutions.

The paper by Dr. Bennett and his co-workers, on "The Significance of Bilateral Basal Ganglia Calcification," is a very good review for all of us to have at hand in the event that we should be confronted with one of these unusual cases. It covers the anatomy, pathology, and chemistry of these changes. Most of us do not see such cases often enough to remember the many points brought out.

I wasn't aware of the large number of different conditions in which basal ganglia calcification is found. The case of the three-week-old child is especially interesting. I wonder if this patient, at birth, may have had convulsions and received calcium and parahormone therapy and then immobilized this calcium temporarily in the ganglia, from which it disappeared. The reason that I suggest this possibility is that we have had a case in which calcium was deposited throughout the lungs following similar treatment for convulsions and two or three years later was no longer demonstrated.

Now, for the last two papers on "Myelography." Dr. Kvernland[1] appears to describe a good procedure for accentuating the posterior compressions of the dural sac. I have observed this type of compression for many years without using this upright dynamic technic but frequently employing large amounts of Pantopaque. So far, however, our surgeons have not been much impressed with this type of myelographic deformity. The cases I have seen have not been related to spinal fusion.

Another condition has been reported that looks something like this, so-called congenital narrowing of the spinal canal. The bony canal is so narrow in its anteroposterior diameter that the dural sac is compressed from behind, resulting in a complete block. If these cases are not carefully explored with this possibility in mind, the surgeon may miss the diagnosis altogether.

I differ in many respects with both essayists on the technic of myelography. I think that the interested radiologist can do this procedure better than anyone else. The spinal puncture and injection and removal of contrast medium should be done with the patient on a fluoroscopic table. Fluoroscopic control is essential to obtain a midline puncture. A 19-gauge needle is preferred to insure more satisfactory punctures. I do not believe it advisable to inject the Pantopaque through tubing, since this adds another chance for contamination. You can avoid the need for injecting through tubing by putting in 0.2 c.c. directly with a syringe and then checking its location fluoroscopically before putting in the rest.

I believe that I differ almost totally with Dr. Silver and his associates. I think my chief reason for disagreeing is the accurate interpretation and exact classification which they attach to the types of deformities presented. Many of them are interpreted as herniated disks on the postoperative myelogram which I would not interpret that way on either the preoperative or postoperative film. It would appear to me that the clinical findings have had a tremendous influence on the evaluation of these myelograms.

I believe, in this connection, that we should classify myelograms into three categories: (1) a definitely positive myelogram; (2) an intermediate or indeterminate type of deformity (I see many cases in which the deformities are indeterminate and conclusive diagnoses cannot be made); (3) finally, the negative myelogram. I don't feel that this negative evidence definitely rules out a herniated disk, even though it is a fairly good evidence against that possibility.

I believe that the postoperative myelogram often falls in the second or indeterminate category and that there may be quite marked myelographic deformities which are not clinically significant. An evaluation of these atypical myelographic deformities is difficult; it should be done independently of the clinical story and should include a long term follow-up of the patients.

As I said initially, this was a large assignment and a difficult one to cover in a short time. I have studied these papers intently and I have learned much from them.

[1] Paper to be published in RADIOLOGY for April 1959.

The Part-Thigh Ratio: A Useful Aid in Evaluating the Uptake of I^{131} by Thyroidal Cancer[1]

MALCOLM Y. COLBY, JR., M.D., and ALAN L. ORVIS, Ph.D.

RADIOIODINE has been used at the Mayo Clinic in the treatment of a certain limited group of patients with thyroidal cancer since 1947. In the main these patients have had distant metastatic foci that selectively concentrated radioiodine. The presence of actively functioning metastatic lesions can frequently be detected by carefully scanning the body with a suitable detector, such as a Geiger counter or scintillation counter. In order to detect or evaluate suspected regions of abnormal radioactivity, however, following the administration of tracer amounts of radioiodine, it is worthwhile to determine in some fashion the distribution patterns of radioactivity to be expected in patients without thyroidal cancer. We have found the technic to be described a simple, reliable, and useful one for the *in vivo* determination of distribution patterns of radioactivity in patients who have received tracer doses of radioiodine.

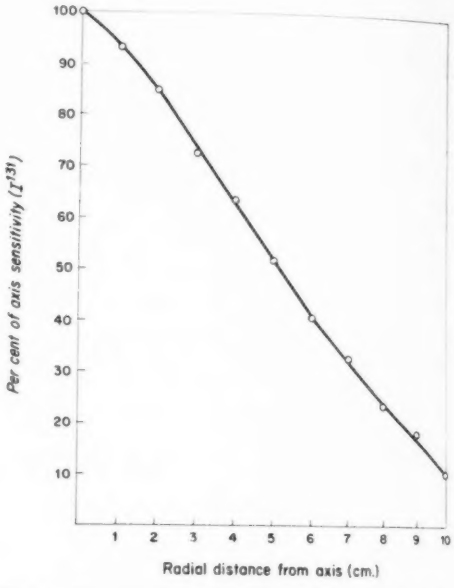

Fig. 1. Per cent of axis sensitivity of I^{131} *vs.* radial distance from axis at 10 cm. from counter tube.

METHOD AND GROUP STUDIED

Briefly, the method consists of measuring the counts per second recorded by placing a properly collimated detector in contact with certain standard spots on the body, always including a site over the anterior lower part of the thigh. Calculations are then made of the ratio of counts per second over the part in question to the counts per second over the thigh.

In our laboratory a Texas type of Geiger-Müller tube surrounded by 1 inch of lead for shielding, with a 3-cm. aperture, is used for the counting. A sensitivity curve for I^{131} at a distance of 10 cm. is shown in Figure 1. The instrument is placed with the collimating cone in gentle contact with the surface of the part in question and counts are obtained; it is then placed over the right thigh at the junction of the lower and middle thirds of the femur and counts are obtained there. The procedure is illustrated in Figure 2. Counts are made routinely at twenty-four and forty-eight hours after oral administration of suitable tracer amounts of radioiodine (I^{131}). Enough counts are obtained to minimize random errors as much as is practicable.

It is essential to maintain a constant detector-tube geometry and a constant spectrum of photon sensitivity in the detector for the resulting ratios to have consistent values for similar distribution patterns of radioactivity.

It should be emphasized at this point that the actual numerical values obtained in different laboratories will vary from one another if identical instrumentation is not

[1] From the Mayo Clinic and Mayo Foundation (M. Y. C., Section of Therapeutic Radiology; A. L. O., Section of Biophysics and Biophysical Research), Rochester, Minn. The Mayo Foundation is a part of the Graduate School of the University of Minnesota.

Accepted for publication in June 1958.

used. An illustration of this point the following short experiment was done. Ratios of part to thigh (part-thigh ratios) were obtained simultaneously with a scintillation detector and a Geiger-Müller counter on a series of 10 patients without cancer. The scintillator had a much higher counting rate, wider viewing angle, and greater sensitivity to scattered photons of reduced energies. It was shown that the part-thigh ratios obtained with the scintillator were higher than those obtained with the Geiger-Müller tube by a factor of 1.6 ± 0.3.

Some of the advantages of the part-thigh ratios over the common practice of simply recording the counts per second over various standard parts are as follows:

1. It is not necessary to maintain a standard tracer dose. For example, it may be desirable to vary the amount of radioactivity in the tracer dose depending on whether radioautography is planned or whether a gammagram is to be obtained.

2. The values obtained are not so greatly influenced by "competitive" radioiodine uptake in other areas of the body (for example, the normal thyroid gland or an avidly functioning metastatic lesion) as are simple counts per second readings. It should be noted parenthetically, however, that the counts over the chest are influenced, in a manner which has been determined, by the percentage of the dose of radioiodine in the thyroid because of scattered radiation from the gland.

3. The values obtained offer a crude, completely empiric, but useful relative measure of the uptake of radioiodine in the part in question.

4. Chronologically successive studies on the same patient are simplified because of the preceding three factors, and a quantitative yardstick of effectiveness of treatment with radioiodine on the radioiodine-concentrating capacity of a metastatic lesion is available.

It should be emphasized that other technics of determining distribution patterns, with the use of specialized mechanized scanning equipment, may give a more detailed distribution pattern. An excellent profile counter is described by Pochin and associates (1). In the average medical isotope laboratory, however, patients for whom such information is needed are relatively rare, and it may be that investment in the more expensive and elaborate types of equipment cannot be justified. "Ratio counting" requires no equipment that is not generally available even in the smallest isotope laboratory.

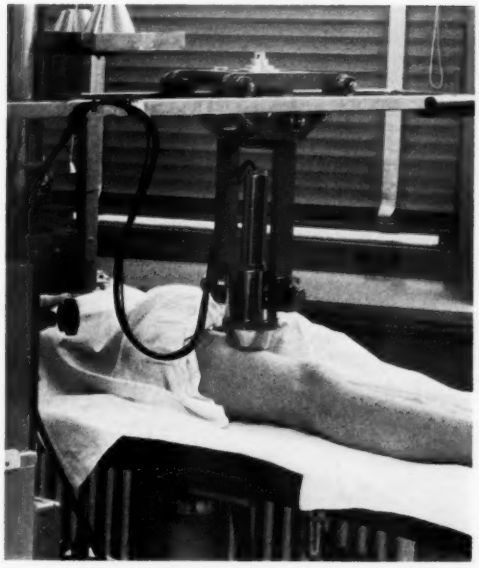

Fig. 2. Geiger-Müller tube in place for obtaining counts over the thigh.

We have determined part-thigh ratios for a total of 201 patients. Group 1 consisted of 82 patients without thyroidal cancer; Group 2, of 45 patients with thyroidal carcinoma, but without evidence of distant metastasis (primarily patients who had undergone operation and were without evidence of recurrence); Group 3 consisted of 32 patients having either thyroidal cancer with distant metastases or metastatic cancer of unknown origin, possibly cancer of the thyroid, and Group 4 numbered 42 patients with thyroidal cancer who were treated with radioiodine. A total of 263 determinations of part-thigh ratios were made on these 201 patients.

Each determination yielded four ratios. The four positions besides the thigh at

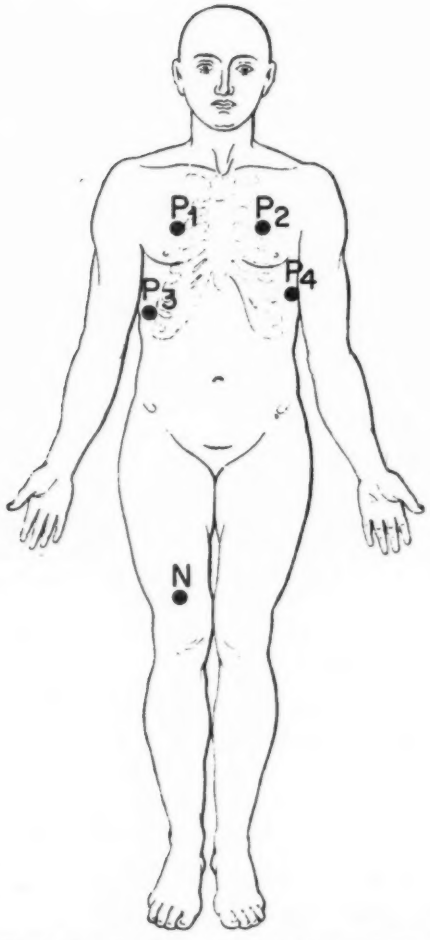

Fig. 3. Location of standard points for readings: P_1 and P_2 are 6 cm. lateral to the midpoint of the sternum. P_3 is in the anterior axillary line, 5 cm. above the costal margin. P_4 is in the midaxillary line 8 cm. above the costal margin. N is on the anterior part of the thigh at the junction of the lower and middle thirds.

which counts were made routinely in all cases were the right midanterior area of the chest (P_1), the left midanterior area of the chest (P_2), the liver (P_3), and the spleen (P_4), as shown in Figure 3. In addition, we are accumulating data on other positions. Certain symmetrical parts of the body may serve as controls in determining the significance of any given ratio and, of course, if abnormal foci are found anywhere in the body, ratio readings are made directly over these areas.

RESULTS

The ratios in Group 1 (normal group) at twenty-four hours after a tracer dose of radioiodine are shown in Figure 4. As might be expected, counts over the chest increase as uptake of radioiodine by the thyroid increases. This is because some of the radiation from the thyroid gland is scattered into the counter by the tissues in the region being viewed by the counter. Thus ratios of counts over the chest tend to be higher with a larger thyroid uptake of the isotope. It also will be seen that the counts for spleen and liver are not influenced by the thyroidal uptake, presumably because of their greater distance from the gland. The ratios of the counts at these sites to that of the thigh are less consistent than those of the chest to the thigh. This may be because of variations in the volume of splenic blood and splenic size and because of the differences in hepatic concentration of radioiodine-tagged metabolites; nevertheless, there appears to be a ceiling ratio of about 11 for ratios between the spleen and thigh rates and of 9 for those between the liver area and thigh. Ratios beyond these ceilings must cause one to suspect a functioning metastatic lesion. The ceiling ratio for both right and left sides of the chest to the thigh seems to be about 10.

The ratios in Group 2 (thyroidal cancer without metastasis) are shown in Figure 5. These ratios do not differ in any essential from those of the normal group. This is as expected, since it is almost certain that no metastatic lesions were present in this group of patients. Data from patients with metastatic thyroidal cancer (Groups 3 and 4) cannot, of course, be used in determining normal ratios.

Generally speaking, in cases in which abnormal twenty-four-hour ratios are found, the determinations should be made also at forty-eight, seventy-two, and ninety-six hours if possible, since these may be of aid in determining whether the high ratio is due simply to increased concentration of radioiodine in the blood or to protein-bound radioiodine in a metastatic process.

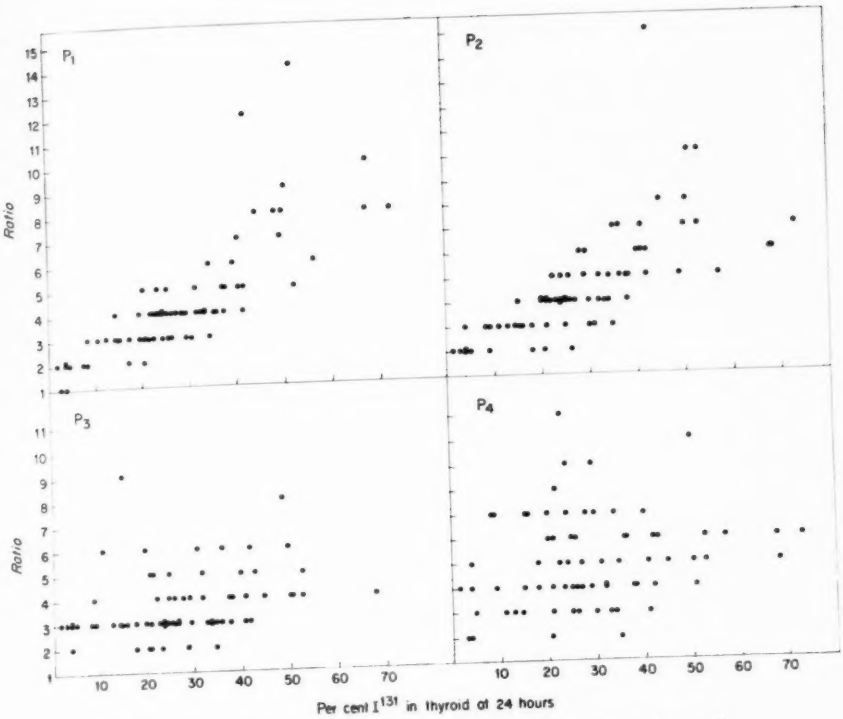

Fig. 4. Part-thigh ratios in Group 1 (patients without thyroid cancer).

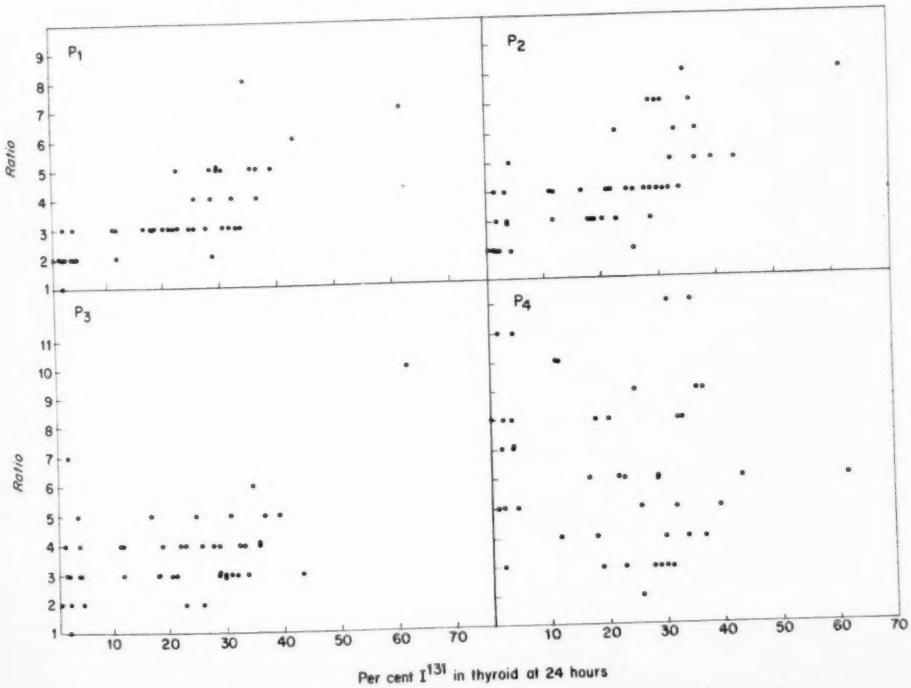

Fig. 5. Part-thigh ratios in Group 2 (patients with thyroid cancer but with no evidence of distant metastasis).

A high ratio due to increased concentration in the blood will usually fall on each successive day; if it is due to protein-bound iodine, it will usually rise each day. This may not be the case, however, when the area in question is near the thyroid gland. In illustration of this point we found that the forty-eight-hour ratios for P_1 and P_2 tended to be slightly higher than the twenty-four-hour ratios in the majority of cases in Groups 1 and 2, due to scatter from the normal thyroid, whereas ratios for P_3 and P_4 tended to be lower than those obtained at twenty-four hours in the majority of the cases.

The following two cases illustrate the use of part-to-thigh ratio.

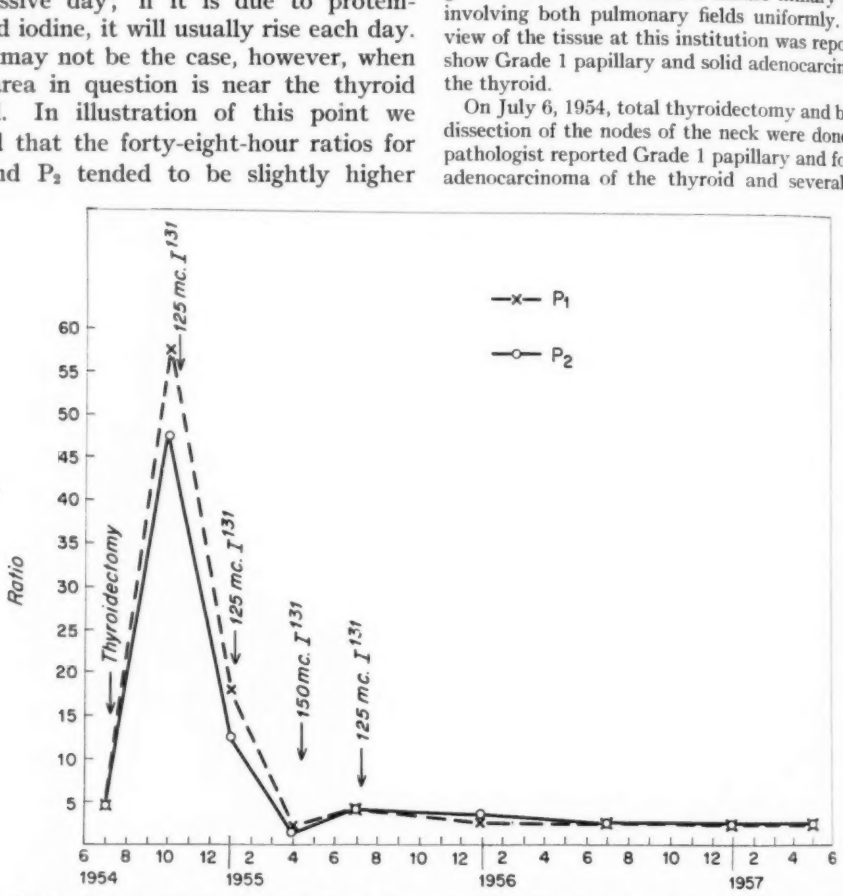

Fig. 6. Case I. Ratios of chest values to those of thigh. The date of total thyroidectomy and the amounts and time of administration of radioiodine are indicated.

REPORT OF CASES

CASE I: A white boy, age 11 years, was first seen at this clinic in July 1954, because recent biopsy of a mass in the left side of the neck, done elsewhere, was reported to show thyroidal carcinoma. Physical examination was essentially negative except for a mass measuring 3 × 4 cm. in the left side of the neck underlying a recent surgical excision. A roentgenogram of the chest showed a diffuse miliary process involving both pulmonary fields uniformly. A review of the tissue at this institution was reported to show Grade 1 papillary and solid adenocarcinoma of the thyroid.

On July 6, 1954, total thyroidectomy and bilateral dissection of the nodes of the neck were done. The pathologist reported Grade 1 papillary and follicular adenocarcinoma of the thyroid and several metastatically involved lymph nodes on either side of the neck. The preoperative part-thigh ratio of radioactivity and the subsequent postoperative ratio in this patient, as well as the time and amounts of radioiodine administered therapeutically, are given in Figure 6. It will be noted that the ratios at P_1 and P_2, which were well within normal limits prior to thyroidectomy, rose rapidly subsequent to this and have steadily diminished under treatment. Incidentally, the diffuse miliary process visible in the lungs completely disappeared by March 1955, and the roentgenogram of the chest has been normal since that time. The boy has been followed periodically to date and he has no evidence of recurrence of the metastatic thyroidal carcinoma.

CASE II: A white boy, age 11 years, was first seen at this Clinic in December 1955. Nodules had

been removed from the thyroid elsewhere in 1952 and again in 1955. Examination when the patient was first seen at the clinic was essentially negative except for bilateral enlarged cervical lymph nodes. In January 1956, total thyroidectomy and dissection of the cervical lymph nodes on the right side were done, followed two weeks later by dissection of the cervical nodes on the left. The pathologist's report was Grade 1 papillary and follicular adenocarcinoma of the thyroid involving the thyroid gland and lymph nodes on each side of the neck. A radioautograph of the tissue removed at operation revealed moderate uptake of radioiodine in the involved nodes. Preoperative tracer studies had revealed no evidence of distant foci of metastasis. A roentgenogram of the chest disclosed nothing abnormal.

Tracer studies made fourteen days after operation revealed a general diffuse increase of radioactivity over both lung fields. In view of the normal roentgenographic findings in the chest, it was decided that no treatment should be given at that time. The patient was re-examined two months later, at which time the radioactivity over the chest had increased further and the patient was found to have remained euthyroid despite total thyroidectomy. Treatment with radioiodine was begun on the assumption that there were metastatic lesions somewhere in the chest even though they were not revealed by the roentgenogram. The chest-thigh ratios prior and subsequent to operation, and to date, as well as the time and amounts of radioiodine administered, are given in Figure 7. It can be seen that the radioactivity over the chest has disappeared under treatment. The patient has remained well, and the roentgenogram of his chest has continued normal.

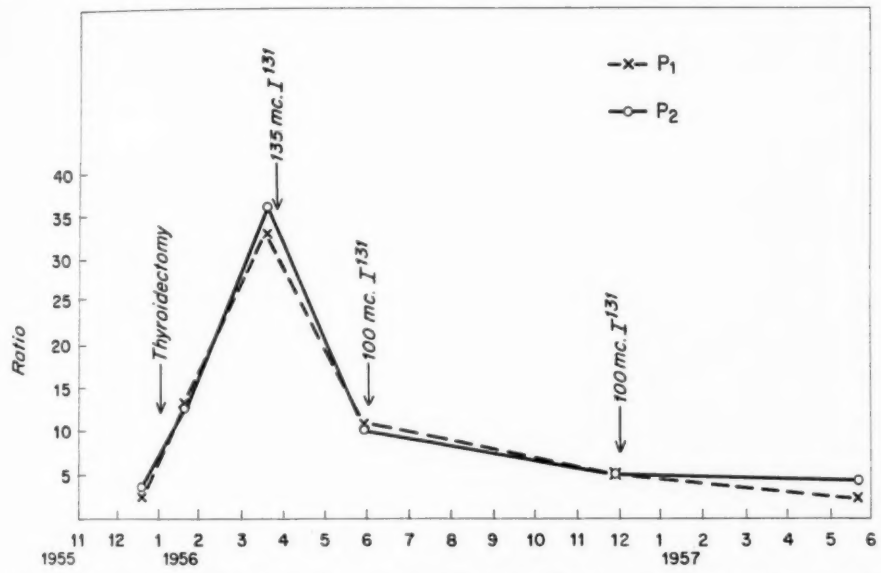

Fig. 7. Case II. Ratios of chest values to those of thigh. The date of total thyroidectomy and the amounts and time of administration of radioiodine are indicated.

SUMMARY

A technic is described for determining patterns of distribution of radioactivity in patients receiving tracer doses of radioiodine in order to search for metastatic thyroidal cancer. This procedure consists of measuring counts per second by placing a collimated detector in contact with certain standard spots on the body, always including a standard spot on the thigh. Calculations then are made of the ratio of counts per second over the various spots to the counts per second over the thigh. Experience with this technic includes 263 determinations on 201 patients. Two cases reported illustrate the clinical value of the method.

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SUMMARIO IN INTERLINGUA

Le Proportion 'Parte Del Corpore' A 'Femore': Un Utile Auxilio In Evalutar Le Acceptation De I^{131} Per Cancere Thyroidal

Es describite un technica pro determinar patronos de distribution del radioactivitate in patientes recipiente doses traciatori de radioiodo in le cerca de metastatic cancere thyroidal. Le methodo consiste de obtener contos per secunda per placiar un collimatate detector in contacto con certe punctos standard in varie partes del corpore, incluse un puncto standard super le femore. Postea calculationes es facite del proportiones inter (1) le contos per secunda in varie punctos al superficie del corpore e (2) le contos per secunda in le puncto standard al superficie del femore. Le experientias con iste technica se basa super 263 determinationes in 201 patientes. Duo casos es reportate como illustrationes del valor clinic del methodo.

Positive Pressure Urethrography: A Roentgenographic Diagnostic Method for Urethral Diverticula in the Female[1]

ERICH K. LANG, M.D., and HUGH JAMES DAVIS, M.D.

THE DIAGNOSIS OF suburethral diverticula in the female has long presented vexing problems to the gynecologist, urologist, and radiologist. Indeed, although the urethra is the most accessible portion of the female genitourinary system, it is the area most infrequently subjected to roentgenographic examination. For the past three years, a new technic of urethrography has been utilized in our clinic, with a marked increase in the diagnosis of this neglected lesion (5, 6).

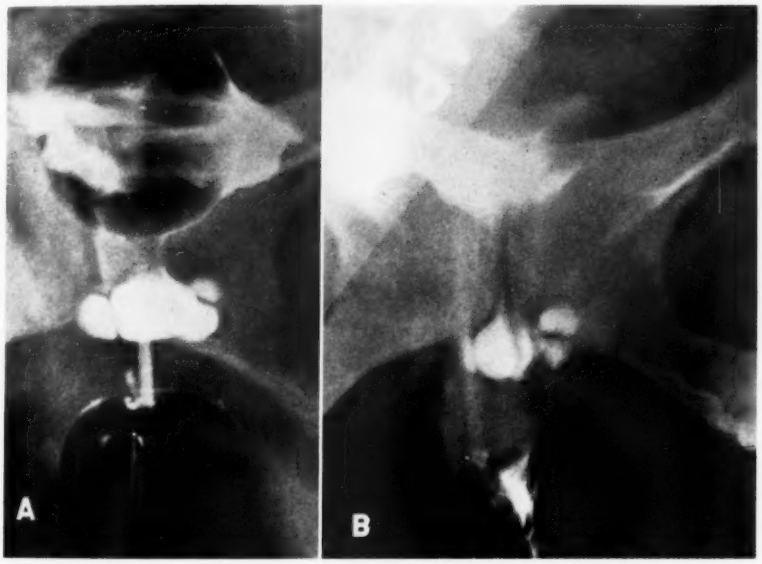

Fig. 1. A. Large compound diverticulum arising from the midurethra in a 57-year-old colored female with symptoms for four years. B. Note retention of medium after removal of the catheter.

Previous methods for female urethrography have relied either upon the simple injection of a contrast medium with a syringe inserted in the external meatus, or upon voiding urethrograms after instillation of the medium into the bladder (1, 2, 11, 13, 14). In the first instance, there is a rapid reflux of the contrast material past the relatively weak internal sphincter into the bladder; in the second instance, there is rarely adequate filling of known diverticula unless their communication with the urethral lumen be unusually large. The fallacy of the assumption that normal micturition pressure may suffice to fill the diverticulum becomes apparent when one studies numerous pathologic specimens showing the usually extremely narrow openings communicating with the urethra. Still a third method relies upon direct injection of the diverticular orifice at cystoscopy, a difficult and often unfruitful maneuver (7). A wide range of contrast media, from thin barium to viscous iodized oils, have been used for injection (9, 13).

This report summarizes experience with

[1] From the Departments of Radiology and Gynecology of The Johns Hopkins Hospital, Baltimore, Md. Accepted for publication in June 1958.

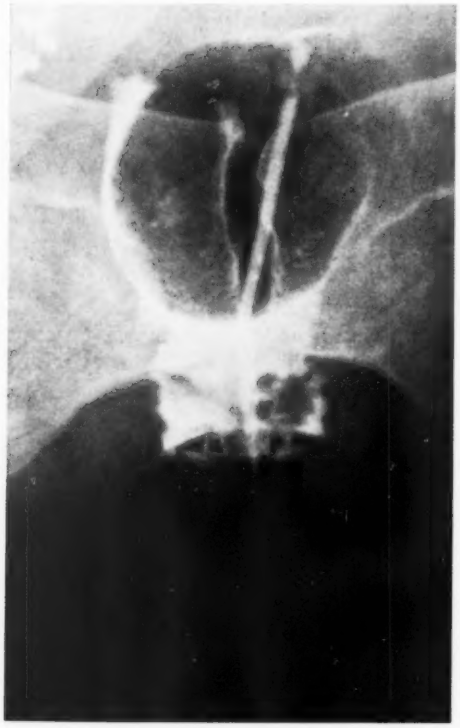

Fig. 2. Filling of the vagina *via* a urethrovaginal fistula, demonstrating the typical vaginal rugae.

108 examinations by the method of positive pressure urethrography. A special urethrographic catheter has been devised, utilizing balloons to obstruct the vesical neck and the external meatus, so that the urethra becomes a closed tube which can be filled with a contrast medium under moderate pressure (5). One or more diverticula have been demonstrated by positive pressure urethrography in 62 examinations, and in only 2 instances was there failure to outline a proved lesion on the initial attempt. A repeat examination was obtained one week later in one of these cases and it is our opinion that the narrow urethral orifice of this diverticulum was occluded when the earlier films were taken. This experience with urethrography as a diagnostic instrument contrasts sharply with reliance on cystoscopic findings alone. Davis and TeLinde (6) reported that in 74 cases of urethral diverticula subjected to cystoscopy, the lesion was never visualized in 12, while in 16 patients four or more unproductive cystoscopies were carried out prior to the discovery of the condition.

Diverticula may occur either as simple saccular structures or they may present as

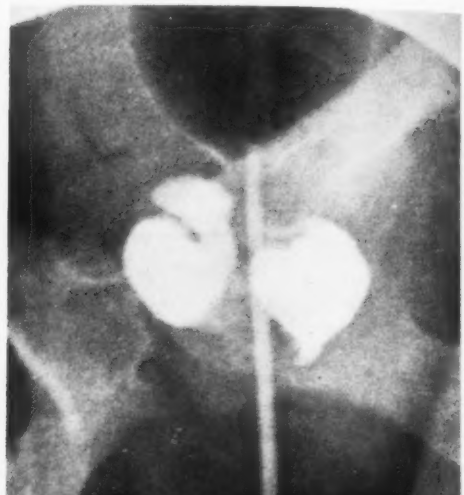

Fig. 3. Diverticula arising as paired structures with fine sinus tracts communicating with the posterior urethra; repeatedly overlooked at cystoscopy.

complex branching sinus tracts. Some of them may be in intimate association with the internal sphincter. Urethrography is an invaluable tool to the surgeon because it provides a three-dimensional appreciation of such lesions. Thirty-two of the patients included in this series had either multiple or compound diverticula demonstrated.

Diverticula arise most frequently from the midurethra. In our series 46 per cent had their origin in that area, 10 per cent from the anterior urethra, and 44 per cent from the posterior urethra (Table I). The

TABLE I: DISTRIBUTION OF DIVERTICULA BY SIZE AND LOCATION

Urethra	Small	Medium	Large
Anterior	6	0	0
Mid	7	12	10
Posterior	7	11	9

preoperative urethrogram facilitates both the initial surgical approach and the ultimate identification of various saccules during operation.

Our increasing reliance upon positive pressure urethrography as a diagnostic tool is apparent from Table II. While

TABLE II: PRIMARY DIAGNOSIS OF URETHRAL DIVERTICULA

	Cystoscopy	Physical Findings	Urethrography
1894–1954	21 per cent	79 per cent	0 per cent
1955–1956	9 per cent	37 per cent	54 per cent

urethrography was not responsible for the primary diagnosis of diverticulum in a single instance prior to 1954, over half of the cases were diagnosed by this method in 1955–56. This should not belittle the classical physical finding of a suburethral mass from which pus is expressed through the external urethral meatus during a routine pelvic examination. Cystoscopy also remains a valuable procedure for the discovery of suburethral diverticula.

The distribution of the diverticula visualized in this study by size and location is shown in Table I. Those less than 0.5 cm. in diameter were considered to be small, while those exceeding 2 cm. in diameter were designated large. It is this latter group of cases which are generally diagnosed clinically, while many women with small or medium-sized lesions discovered radiographically have been followed for many years because of "unexplained" recurrent urinary tract infection.

TECHNIC

A special catheter has been devised for use in positive pressure urethrography (5), consisting basically of a 14F Foley catheter with a 30-c.c. bag and, in addition, a second sliding balloon which can be moved up and

Fig. 4. Compound diverticulum arising in the posterior urethra of a 30-year-old colored female with a six-month history of dysuria and hematuria. Note the demonstration of Skene's glands, entirely normal structures.

down the catheter stem. The catheter is advanced into the bladder. The bag is then inflated and drawn against the sphincter. Injection of a viscous contrast medium is started with the external meatus still unobstructed. This maneuver serves to clear the system of air, urine, and residual pus. As soon as there is reflux of the contrast material from the external meatus, the sliding balloon is pressed against the external meatus, tamponading the outflow tract. Traction is maintained on the vesical balloon until the inflation of the distal sliding balloon is completed, which locks it into position. Approximately 3 or 4 c.c. of additional contrast medium is then gradually injected through an opening in the central portion of the catheter now resting in the urethra. The pressure exerted by the additional injection of contrast medium will effect the filling of any diverticula arising from the now tamponaded urethra. Anteroposterior and anterior oblique films

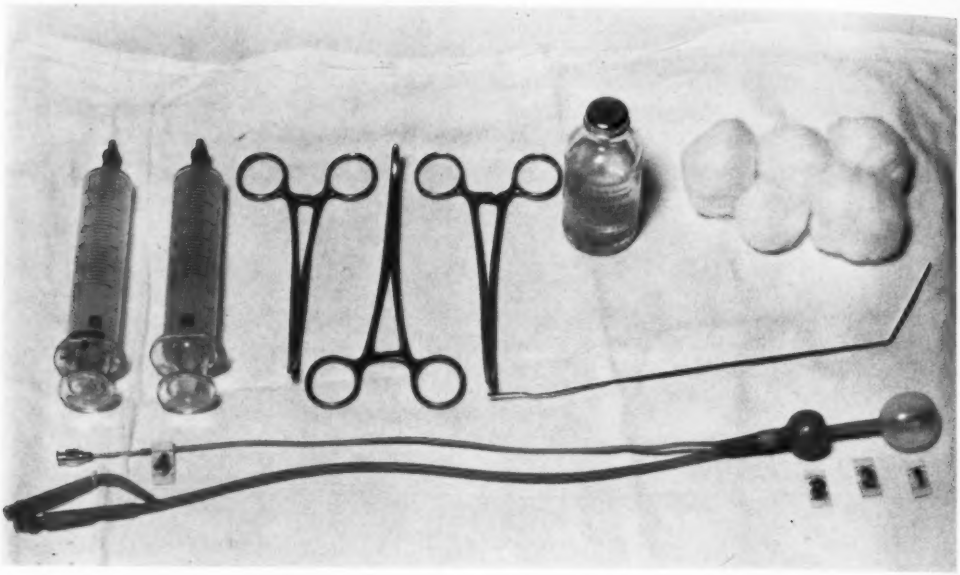

Fig. 5. Equipment as utilized for urethrographic examinations. 1. Vesical balloon inflated with 20 c.c. of air to tamponade the internal orifice. 2. Sliding balloon which is advanced to occlude the external meatus. 3. Intraurethral segment of catheter containing orifice for injection of contrast material. 4. Tubing for inflation of sliding balloon. The probe can be inserted through the eye of the catheter to facilitate its introduction into the urethra.

are now obtained. After this, the external balloon is deflated and gently drawn away from the external meatus. The bladder balloon is also completely deflated and the catheter is carefully removed. A delayed film obtained after this maneuver has demonstrated residual filling of the diverticula in 58 of 62 cases.

Patients in whom retention of the medium following withdrawal of the catheter is not demonstrable are not considered to be candidates for surgical intervention. On occasion there is a symmetric dilatation of the ampullary portion of the urethra just at the external meatus, and this is considered a normal variant. In our series, Umbradil-Viscous U, a water-soluble medium containing hydroxymethylcellulose, and Thixokon, a thickened sodium acetrizoate solution, have been used as contrast media. We have not encountered any allergic or anaphylactic reactions in any of our patients. A 4-inch cone is employed routinely to improve definition and minimize irradiation of the ovaries.

SUMMARY

A technic utilizing positive pressure urethrography for demonstration of suburethral diverticula is described. Results in 108 examinations by this new technic demonstrate its importance as a primary diagnostic tool for the discovery of diverticula.

Positive pressure urethrography is also a useful adjunct in the management of known diverticula, since it furnishes a preoperative three-dimensional appreciation of the lesion, facilitating the surgical approach. The method is applicable to the demonstration of urethrovaginal fistulas or sinus tracts as well as abscess cavities arising from the urethra.

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SUMMARIO IN INTERLINGUA

Urethrographia A Pression Positive: Un Methodo De Diagnose Roentgenographic Pro Diverticulos Urethral In Femininas

Es describite un technica que utilisa urethrographia a pression positive in le demonstration de diverticulos suburethral in femininas. Le resultatos obtenite per iste methodo in 108 examines demonstra su importantia como manovra diagnostic primari in le discoperta de diverticulos. Urethrographia a pression positive es etiam utile como adjuncto in le tractamento de diverticulos cognoscite, proque illo provide ante le operation un conception tridimensional del lesion e facilita assi le intervention chirurgic. Le methodo es applicabile al demonstration de fistulas o de tractos sinusal e etiam de cavitates de abscesso que ha lor origine in le urethra.

Isodose Curves for Horizontal Rotation Therapy with 2 MVP Roentgen Rays[1]

NORMAN A. BAILY, Ph.D., and VIRGIL E. YODER, M.S.

THE USE OF rotational roentgen therapy in the horizontal plane has been discussed by various authors (1–3). The use of this technic has proved efficacious in a variety of situations. By proper choice of beam angulation and port size, it is possible to irradiate tumor volumes having a wide range of sizes and lying at various depths in the body, with the following advantages. First, although it is true that with x-rays of the energy employed (2 MVP) the skin dose is low, the underlying tissues receive high doses in comparison to the tumor dose (4), unless multiple ports are used. With horizontal rotation the dose in this region ranges between 10 and 20 per cent of the tumor dose. Second, exit doses are considerably lower than when a multiple port technic is utilized. Third, the irradiated volume approximates the shape of a sphere, whereas arc technics irradiate cylindrical volumes. Fourth, vital tissues such as the vertebral column, rectum, bladder, etc., can be spared large amounts of radiation while adequate dosage to the tumor volume is still provided. Fifth, positioning and immobilization of the patient are considerably easier than when vertical rotation is used.

One of the disadvantages of horizontal rotation has been the necessity for using wax cones in conjunction with the wedge filter. We have been able, with 2-MVP radiation, to design a wedge filter which eliminated the need for a wax cone.

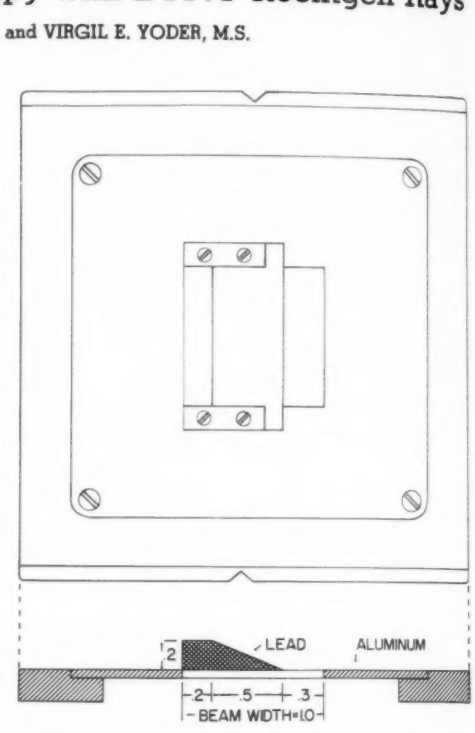

Fig. 1. Wedge filter for rotation therapy in the horizontal plane with 2-MVP x-rays. The filter is constructed of lead and has been built for beams of 6 × 6 cm., 8 × 8 cm., and 10 × 10 cm., calculated at a target-skin distance of 100 cm.

EXPERIMENTAL STUDY

Dosages were determined with a Bombke dosimeter with integrator, the dosage at each point being recorded over one complete rotation. Isodose curves could then be constructed by comparison of the integrated dosage at each point. The thimble chamber used in conjunction with the dosimeter had an approximate volume of 0.046 c.c. The probe and dosimeter were calibrated against a Victoreen 250-r thimble chamber previously calibrated at the National Bureau of Standards.

The x-ray beam used was generated by a General Electric 2-MVP self-rectified resonant generator. The half-value layer of this beam is 7.6 mm. lead (5). The output was controlled by careful maintenance of the potential and current settings through observation of the respective meters. Further monitoring of the beam

[1] From the Department of Radiation Therapy, Roswell Park Memorial Institute, Buffalo, N. Y. Accepted for publication in June 1958.

was not considered necessary since dosages recorded were averages over two minutes (one complete rotation), and small fluctuations should therefore balance out. Frequent runs of the recorded dose at the central focus were made as a check on both machine and dosimeter operation.

this arrangement, the position of the ionization chamber is indicated directly on cross-section paper. Adjustments in depth were made manually by means of a calibrated scale inscribed on the support arm. The data obtained in this manner were then cross-plotted to yield the result-

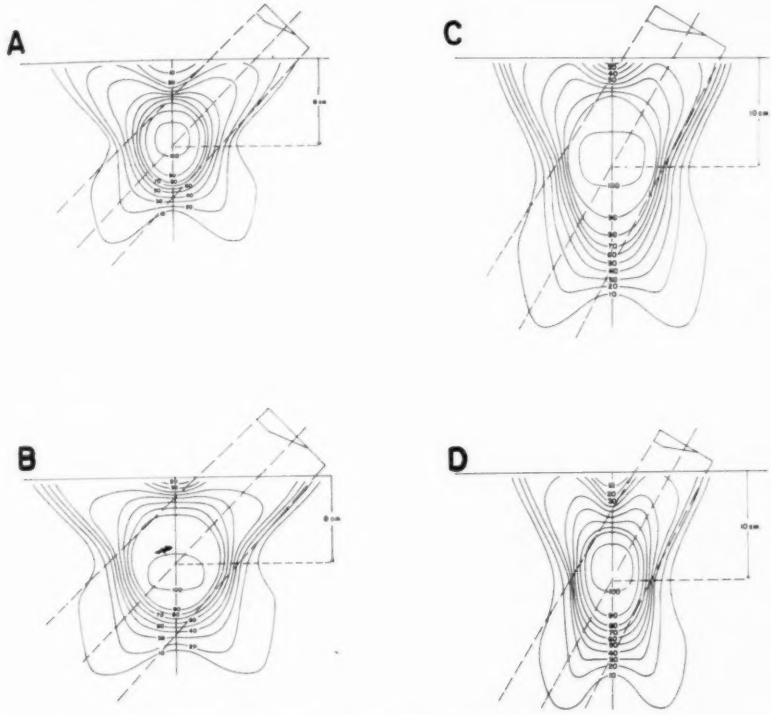

Fig. 2. Isodose contours obtained for 2-MVP x-rays, F.S.D. 100 cm., in a water phantom.
A. Field size, 6 × 6 cm.; tumor depth, 8 cm.; beam angulation, 45°.
B. Field size, 8 × 8 cm.; tumor depth, 8 cm.; beam angulation, 45°.
C. Field size, 8 × 8 cm.; tumor depth, 10 cm.; beam angulation, 30°.
D. Field size, 6 × 6 cm.; tumor depth, 10 cm.; beam angulation, 30°.

The maximum deviation shown was 3.2 per cent, and the average deviation was 0.2 per cent.

The phantom used was a water-filled Lucite tank 53 × 53 × 53 cm. The probe was water-proofed by a thin rubber sheath made water-tight at the cable entrance by ceresin wax.

The positioning of the chamber was accomplished remotely by a selsyn drive incorporated in an apparatus similar to that described by Trout *et al.* (6). In

ant isodose curves. The points were then connected by the best smooth curves.

The tank was set so that the central axis of the beam entered the phantom surface at a distance of 100 cm. from the target. No cone or other positioning device was in place while readings were being recorded. The wedge filter was attached to the front surface of the machine, placing it at a distance of 53.5 cm. from the target.

The wedge filter was designed as de-

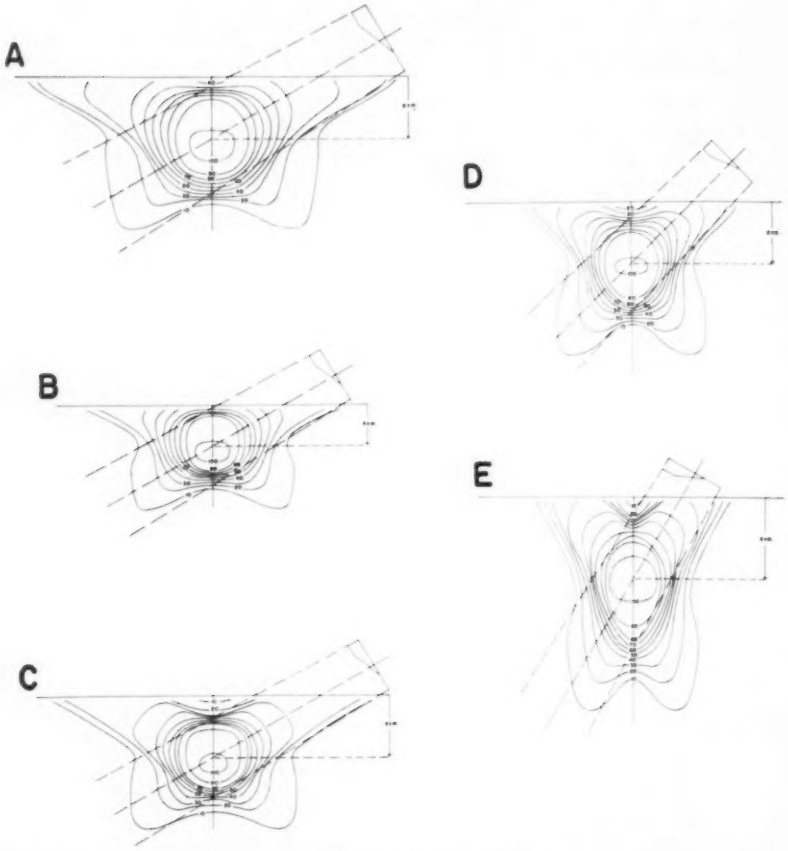

Fig. 3. Isodose contours obtained for 2-MVP x-rays, F.S.D., 100 cm., in a water phantom.
A. Field size, 8 × 8 cm.; tumor depth, 6 cm.; beam angulation, 60°.
B. Field size, 6 × 6 cm.; tumor depth, 4 cm.; beam angulation, 60°.
C. Field size, 6 × 6 cm.; tumor depth, 6 cm.; beam angulation, 60°.
D. Field size, 6 × 6 cm.; tumor depth, 6 cm.; beam angulation, 45°.
E. Field size, 6 × 6 cm.; tumor depth, 8 cm.; beam angulation, 30°.

scribed by Tranter (7), but constructed of lead. This filter when used without a wax cone was found to place the point of highest dose considerably below the focus of the beam. Through experimental trial and error technics, it was found possible to construct a filter which when used by itself would produce the maximum dose close to the focus and, in addition, provide an approximately spherical isodose distribution. The same design, that is if dimensions are kept in the same ratio, has been found to be satisfactory for all field sizes and angles of entry investigated. This filter is shown in Figure 1.

RESULTS

With the wedge filter, without the use of a wax cone, isodose contours were obtained for three field sizes, 10 × 10 cm., 8 × 8 cm., and 6 × 6 cm. The imaginary tumor depths and angulation of the beam were chosen to cover as complete a variety of clinical situations as seemed feasible by this technic. In the case of the 6 × 6-cm. field, tumor

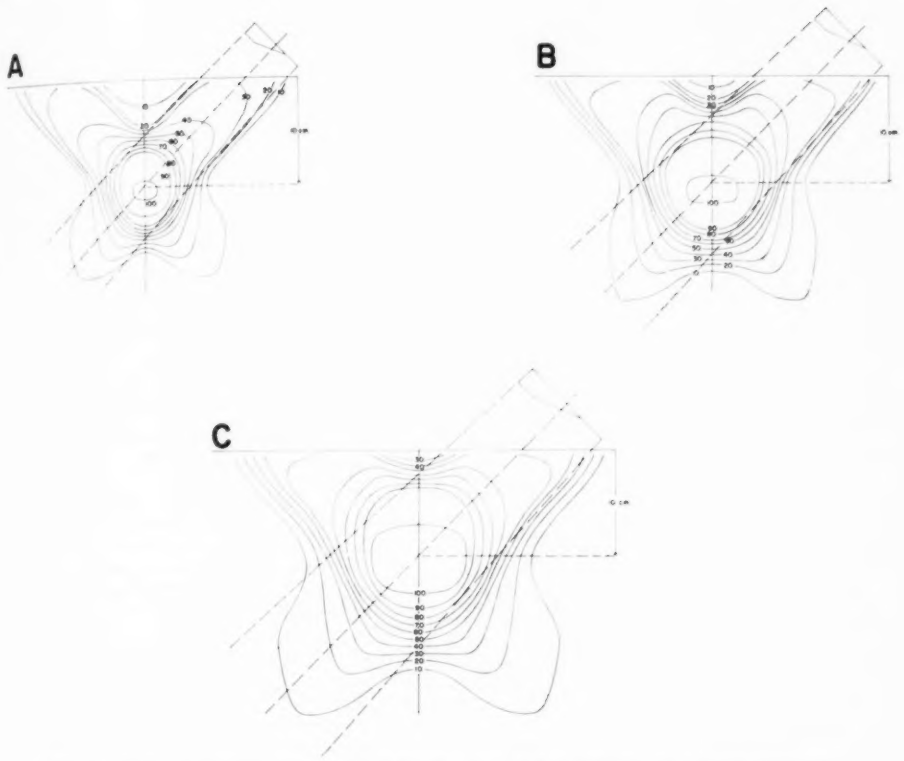

Fig. 4. Isodose contours obtained for 2-MVP x-rays, F.S.D. 100 cm., in a water phantom.
A. Field size, 6 × 6 cm.; tumor depth, 10 cm.; beam angulation, 45°.
B. Field size, 8 × 8 cm.; tumor depth, 10 cm.; beam angulation, 45°.
C. Field size, 10 × 10 cm.; tumor depth, 10 cm.; beam angulation, 45°.

depths ranging between 4 cm. and 10 cm. were investigated. For a field size of 8 × 8 cm., curves were obtained for depths of 6 cm., 8 cm., and 10 cm. For the largest field investigated, 10 × 10 cm., only a tumor depth of 10 cm. has been studied. Where feasible, the angulation of the beam was varied so that this factor might be evaluated. The experimentally obtained isodose contours are shown in Figures 2–4.

Tumor-air ratios for each field size, tumor depth, and beam angulation, are given in Table I. Also given, in the last column of this table, are the ratios of the integral dose delivered by the method of horizontal rotation as against those delivered by two opposing ports of the same size.

DISCUSSION

The isodose contours shown in Figures 2, 3, and 4 have all been terminated 4 mm. below the surfaces of entry. This has been done since it has been shown (4) that thimble chamber readings in this region are incorrect.

With the exception of the 100 per cent contour, and the regions of maximum dosage, the irradiated volumes are approximately spherical. In addition to the oval shape of the 100 per cent contour, its center is displaced. For angles of entry of 30° the center is slightly above or at the focus, while for larger angles the center of this contour generally lies below the focus. In many instances, however, this shift is reversed in the 90 per cent contour, though in general the 90 per

TABLE I: TUMOR-AIR RATIOS AND INTEGRAL DOSAGE WITH HORIZONTAL ROTATION TECHNICS

Field Size (cm.)	Tumor Depth (cm.)	Beam Angulation (degrees from vertical)	Tumor/Air Ratio	Ratio of Integral Dose with Horizontal Rotation to That with Two Opposing Ports
6×6	4	60	0.515	1.02*
6×6	6	60	0.411	0.93
6×6	6	45	0.488	0.75
6×6	8	45	0.430	0.85
6×6	8	30	0.464	0.79
6×6	10	45	0.358	1.05
6×6	10	30	0.418	0.80
8×8	6	60	0.377	1.00
8×8	8	45	0.371	0.94
8×8	10	45	0.338	1.30
8×8	10	30	0.385	0.97
10×10	10	45	0.342	1.33

* Single port.

cent contour is symmetrical about the focus. This latter situation also applies for the lower valued isodose contours. The diameter of the volume irradiated within the 90 per cent contour closely approximates the beam size. The dose found at the geometrical boundary of the beam at the focus depth was 20 per cent of the central tumor dose when the beam angulation was 60° and increased with decreasing angulation and tumor depth. With the exception of the 60° angulation, this dose averaged about 50 per cent of the central focus dose.

The range of dosage variation within the 100 per cent contour was 6 per cent. The average deviation for all fields studied was 0.4 per cent.

Because of the oblique path of the beam, the integral dose delivered with this technic is quite high. The tumor-air ratios and the ratios of the integral dose delivered by use of horizontal rotation to that delivered through two opposing ports as given in Table I show the importance of choosing the most advantageous angulation of the beam and using the smallest field size consistent with the clinical requirements.

SUMMARY

A wedge filter for use in horizontal rotation with 2-MVP x-rays has been devised. This filter is shown to produce satisfactory isodose contours in a water phantom, without the use of a wax cone.

Isodose contours for a variety of field sizes, tumor depths, and beam angulations have been determined experimentally.

Integral dosage delivered by horizontal rotation is compared with that delivered through two opposing ports, with field size equal to that used for horizontal rotation.

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SUMMARIO IN INTERLINGUA

Curvas Isodosal Pro Therapia A Rotation Horizontal Con Radios Roentgen de 2 MVP

Le uso de therapia rotational in le plano horizontal ha multe avantages. Un del disavantages, usque nunc, esseva le necessitate de usar conos de cera in conjunction con le filtro cuneal. Le autores ha disveloppate un filtro cuneal al uso con radios Roentgen de 2 MVP, le qual elimina le mentionate requirimento. Con iste filtro

e sin un cono de cera, le dose maximal es producite proxime al foco del fasce, e un approximativemente spheric distribution isodosal es effectuate.

Contornos isodosal esseva obtenite pro campos de tres dimensiones, pro tumores de varie profundores, e con variationes in le angulation del fasce. Le proportion inter le dose integral delivrate per le technica describite e le dose integral delivrate via duo opponite portas varia inter 0,75 e 1,33. Le observationes indica le importantia de seliger le plus avantageose angulation del fasce e le plus micre campo ancora compatibile con le requirimentos clinic.

Observations on the "Normal" Spleen[1]

CAPT. BYRON G. BROGDON, USAF (MC), and CAPT. NEIL E. CROW, USAF (MC)

THE SPLEEN IS involved secondarily by many diseases and primarily by relatively few. Fortunately, practically all affections of the spleen are manifested morphologically by its enlargement (2). The spleen may be examined radiographically by special contrast methods, by its relationship to adjacent structures, and by study of its outline on the plain film.

The contrast methods—pneumoperitoneum, injection of intravenous thorium dioxide, and direct introduction into the spleen of soluble iodine compounds—entail risk of pain, morbidity, delayed malignant change, and hemorrhage (1, 3, 4, 5).

By virtue of its relationship with other organs in the left upper quadrant, the spleen, if sufficiently enlarged, may be indirectly localized by downward displacement and impression upon the splenic flexure of the colon, elevation of the diaphragm, anteromedial displacement of the stomach, or inferomedial displacement of the left kidney. However, minimal changes in size may not bring about significant changes in these neighboring structures.

Frequently the spleen may be identified on abdominal films of good quality as a tongue-like soft-tissue density in the left upper quadrant, extending laterally to the rib cage. On occasion the splenic notch may be visualized for more positive identification.

Wyman (6) introduced a method of direct mensuration of the spleen on films of the abdomen, determining the width of the organ at a point 2 cm. above the tip of the lower pole. On films of 199 adult patients consecutively studied (gastrointestinal, gallbladder, urinary tract, and lumbar spine examinations), he found an average width of 3.5 cm. The range was 2.0–4.6 cm. All films were exposed in the anteroposterior projection utilizing a 36-inch target-film distance, presumably with the patient recumbent. Wyman showed that widening of the splenic shadow beyond these limits was a valuable and reasonably constant finding in traumatic rupture of the spleen.

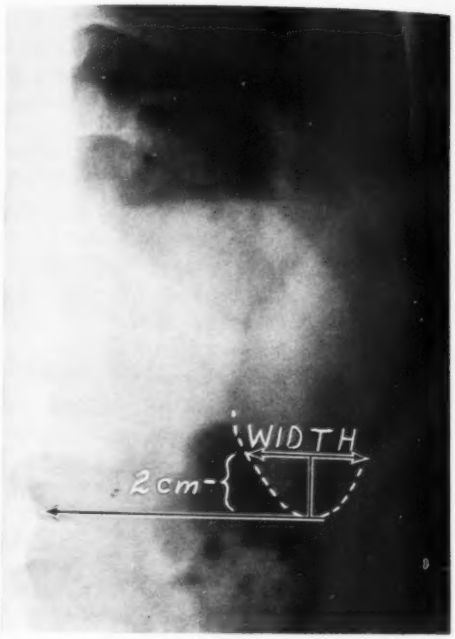

Fig. 1. Visualization of the spleen on routine anteroposterior film of the abdomen. The method of measurement employed in determining size and position of the inferior pole is demonstrated.

A reliable index of splenic size, as suggested by this method, is of obvious value in the radiographic diagnosis of splenomegaly of any etiology. It was felt, however, that a larger series in patients presumed to be "normal" would be desirable and would further validate the normal limits previously determined. Additionally, a standard applicable to the erect

[1] From the Radiology Service, 2349th USAF Hospital, Parks Air Force Base, California. Accepted for publication in July 1958.

film seemed necessary in view of the widespread use of both erect and recumbent projections in abdominal diagnosis and because of the inconstancy of splenic visualization in either position.

METHOD

Films of the abdomen of 936 Air Force Academy and Aviation Cadet applicants were reviewed. The subjects were all males in the seventeen to twenty-seven year age range, in apparent good health at the time of examination. The double-reading technic was employed, and measurements were performed as outlined by Wyman (6) and as illustrated in Figure 1. All films were exposed in the anteroposterior projection, during expiration, utilizing a 36-inch target-film distance. Size and position of the spleen are based on recumbent films in 89 cases and erect films in 302 cases.

RESULTS

In no case was the entire spleen outlined. The inferior pole could be delineated in 416 cases (44.4 per cent). In 391 cases (41.8 per cent) visualization was adequate for measurement.

The size of the inferior pole did not vary with position, the average width being 3.4 cm. in both erect and recumbent series; 382 cases (97.7 per cent) were within a 2.0 cm. to 4.5 cm. range. In 2 of the cases in which the width exceeded 4.5 cm. sickle-cell trait was subsequently diagnosed. Follow-up was not possible on the others.

In both erect and recumbent groups, the tip of the inferior pole of the spleen was most often at the level of the second lumbar vertebral body. When the two groups are compared (Table I), a tendency for the tip to range toward lower levels in the erect patient is apparent.

TABLE I: LEVEL OF INFERIOR TIP OF SPLEEN

Vertebral Level	T12	T12-L1	L1	L1-L2	L2	L2-L3	L3	L3-L4	Total
Recumbent group	7	6	13	11	40	11	1	0	89
Erect group	0	2	25	46	126	70	52	6	327

SUMMARY AND CONCLUSIONS

The lower pole of the spleen may be visualized on anteroposterior films of the abdomen in 44.4 per cent of cases examined. Nonvisualization is not considered pathologically significant.

The average width of the normal spleen at a point 2 cm. above the tip of the inferior pole, as seen in both recumbent and erect positions, is 3.4 cm. This measurement may be used as an index of splenic size in the roentgen diagnosis of splenomegaly.

The tip of the spleen usually lies at the level of vertebral body L-2 in both erect and recumbent patients, but ranges toward lower levels in the former position.

Ranges of normal size and position are given.

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SUMMARIO IN INTERLINGUA

Observationes Relative Al Splen "Normal"

Le polo inferior del splen pote esser visualisate in pelliculas antero-posterior del abdomine in 44,4 pro cento del casos examinate. Non-visualisation non es considerate como pathologicamente significative.

Le largor medie del splen normal a un puncto 2 cm supra le puncta del polo inferior, visualisate in position recumbente e etiam in position erecte, es 3,4 cm. Iste mesura pote esser usate como un indice del dimension splenic in le diagnose roentgenologic de splenomegalia.

Le puncta del splen jace usualmente al nivello del corpore vertebral L-2, in patientes in position erecte e etiam recumbente, sed nivellos plus basse occurre in le prime del duo positiones mentionate.

Variationes de dimension normal e de position normal es presentate.

SUMMARIO IN INTERLINGUA

Fracturas Del Calcaneo, Causate Per Effortio

(*Pagina 415*)

Dece-tres fracturas del calcaneo, causate per effortio, esseva incontrate in 10 individuos, omnes recrutas del statounitese Corps de Marina. Es exprimite le opinion que medicos in general—civil e militar—non es sufficientemente conscie de iste condition. In nostre experientia le numero del observationes de tal fracturas cresceva marcatemente con le recognition de lor possibilitate. Le condition de un fracturate calcaneo deberea esser suspicite in le presentia de dolores e tumescentia del calce occurrente in personas qui se trova confrontate subitemente con le effortios de un augmentate activitate pedal. Illo pote esser recognoscite radiologicamente per un area linear de reaction de osso dense, anterior al margine posterior del calcaneo. In le curso del tres menses depost le redaction del precente articulo, 23 casos additional esseva vidite. Le serie total monta assi a 42 casos.

Stress Fractures of the Calcaneus[1]

ALAN C. WINFIELD, M.D.,[2] and LIEUT. J. M. DENNIS, MSC, USN[3]

STRESS OR MARCH fractures were first recognized as an entity in 1855 by Breithaupt (1). Since then, these fractures, which are variously referred to as march, stress, insufficiency, fatigue, and pseudo-fractures, have been described in many bones throughout the body, particularly in the lower extremities. They are most commonly seen in the metatarsals, tibia, and fibula. Stress fractures of the calcaneus are less frequently reported. They are mentioned by Shanks and Kerley in their text (3), and Watson-Jones considers them in passing, quoting Asal, who reported 600 stress fractures from German Army hospital records during World War II, of which 0.6 per cent (4 cases) were of the calcaneus (4). Hullinger in 1944 submitted the only relatively extensive series which we have been able to find in the literature (5)—53 cases.

Our experience has been that, although this entity is essentially unknown to most military and civilian physicians, it is not as infrequent as is generally believed, particularly among military personnel. We are planning further publication in terms of the frequency of calcaneal stress fractures in relation to similar lesions of other bones of the lower extremity. We feel, however, that the significance and incidence of the condition warrant the present report.

Our attention was first called to stress fractures of the calcaneus in January 1958, when our first case was observed. We have since discovered 8 additional cases, 3 of which were bilateral. This brings our total to 12 within five months. The incidence of bilateral occurrence is in agreement with Hullinger's figure of 33 per cent. During the entire calendar year 1957 we had not recognized a single instance of this lesion, but a review of the films from that period demonstrated 1 case in retrospect, bringing our total to 13. Failure to recognize this case originally and the small number of cases seen formerly we attribute primarily to the lack of awareness of the entity on the part of both radiologists and clinicians. The earlier cases in our series came to the attention of our X-ray Department only after several days or weeks of physiotherapy directed toward what was clinically diagnosed as a tenosynovitis of the Achilles tendon. We wonder, therefore, if many other cases have so masqueraded and have evaded radiographic examination. Since our first several cases, the index of clinical suspicion at this establishment has been much higher; the overall number of os calcis examinations has been far greater, and the number of stress fractures of the calcaneus recognized correspondingly raised.

Fig. 1. A fine but definite break in the cortex with minimal degree of callus is demonstrated very clearly in this case. Note also the characteristic dense bone reaction anterior to the epiphysis.

[1] From the X-ray Department, U. S. Marine Corps Recruit Depot, San Diego, Calif. Submitted while the authors were on active duty in the U. S. Naval Reserve at the U. S. Marine Corps Recruit Depot. Accepted for publication in June 1958. The opinions and conclusions expressed in this article are those of the authors, and not necessarily those of the Department of the Navy.

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[3] Podiatrist, U. S. Marine Corps Recruit Depot.

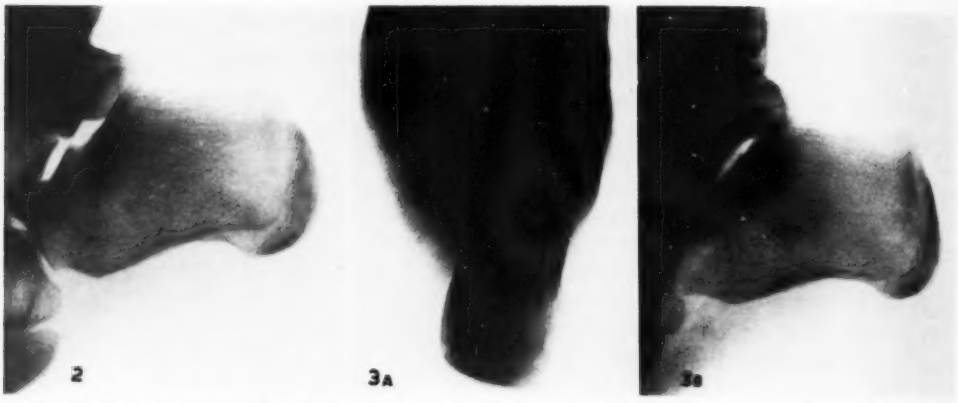

Fig. 2. Case I. The original film (4-21-58) shows a hazy questionable area of increased density lying immediately anterior to the epiphyseal plate. This was diagnosed as a possible stress fracture and repeat studies were advised in one week.

Fig. 3. Lateral and axial projections one week later demonstrate a definite increase in the bony reaction, verifying the original diagnosis.

CLINICAL MATERIAL

The clinical material utilized in this study was the recruit population at the U. S. Marine Corps Recruit Depot in San Diego. About 8,700 men in their late teens and early twenties have been processed at this base between the time of discovery of the first case of stress fracture of the calcaneus and the submitting of this report. These gave us a large segment of population homogeneous as to sex, age, activity, and temporary living conditions. The group was extremely diversified, however, in respect to race and previous conditions of occupation, activity, nutrition, and environment. There was a common factor of sudden increase in pedal activity, exemplified by marches, "double timing," jumping exercises, and the like.

CLINICAL SYMPTOMS

The histories obtained from patients with stress fracture of the calcaneus were generally consistent, showing gradual onset of pain and swelling of the heel. No recollection of acute sudden trauma could be elicited in the typical case, but frequently the symptoms were said to develop shortly after a particularly rigorous episode of marching, "double timing," or running the obstacle course. There was usually a delay of from several days to two weeks between the onset of symptoms and the time of reporting to the dispensary. Physical examination revealed swelling around the calcaneus, which as a rule was quite tender. There was frequently tenderness also along the course of the Achilles tendon. Originally all the men were treated on the basis of a multitude of diagnoses, the most frequent of which was tenosynovitis. Management usually consisted of physiotherapy, whirlpool, and "light duty," until subsequent roentgenograms made possible the correct diagnosis. After identification of several of these cases, the index of suspicion was raised and films were taken earlier. Invariably, however, symptoms were present for one to two weeks before positive radiologic identification of the lesion.

RADIOGRAPHIC CRITERIA

Routine lateral and axial projections are taken in all calcaneus examinations. The constant roentgen sign of stress fracture is a dense line of increased bone reaction running anterior and parallel to the posterior margin of the calcaneus, the distance from the latter varying from case to case. Such a line, it is noted, runs almost at right angles to the normal trabecular pattern, which consequently is disrupted in this area of increased bone

reaction. The density undoubtedly represents the bone formation due to healing at the site of the fracture. Hullinger stated that in his series of cases a defect in the cortex was almost never seen. On the other hand, we have demonstrated a

Fig. 4. Case II. Lateral exposure four weeks after the onset of symptoms. Note the suggestion of an irregular defect in the superior margin of the os calcis.

definite cortical crack in several of our films (Fig. 1). We have never seen any displacement or any loss of Böhler's angle nor have we encountered evidence of joint involvement. We have been able, on occasion, to identify callus adjacent to the cortical defect but this has been relatively unusual (Figs. 1 and 5). The most significant finding, to reiterate, is the linear area of dense bone reaction, occurring at least one week—usually longer—after the original onset of symptoms, and changing during the course of healing. This appearance has not been observed in any asymptomatic recruit as an incidental finding.

TREATMENT

When symptoms are acute, several days of bed rest to reduce the swelling and alleviate the pain are needed. A strict regime of "light duty" with diminished weight-bearing is then sufficient, and there is slow but steady improvement. Our one attempt at plaster-casting did not appreciably aid the healing but rather seemed to delay the course of repair and disappearance of pain.

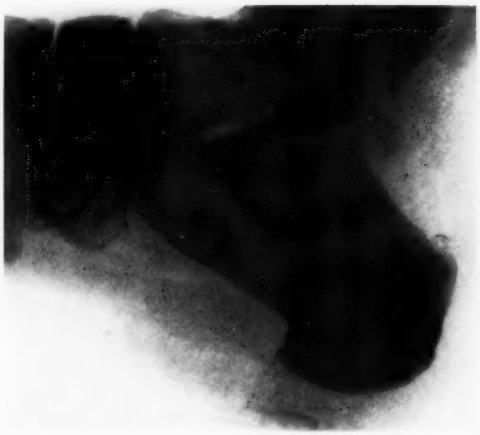

Fig. 5. Case II. Roentgenogram taken one week after that reproduced in Fig. 4, showing increased calcium deposition in the area, suggesting a cortical defect. We feel that this represents true callus formation adjacent to the cortical crack.

CASE REPORTS

CASE I: D. H., an 18-year-old Caucasian, was first seen about three weeks after he began training at the Recruit Depot, and ten days after swelling and pain in the region of the right heel were noticed. No definite trauma was recalled. Roentgen studies at this time (Fig. 2) were interpreted as showing a rather questionable area of increased bone reaction immediately anterior to the epiphyseal plate, and the diagnosis of stress fracture of the calcaneus was suggested. The patient was put on bed rest and the studies were repeated one week later (Fig. 3). At that time both the lateral and axial views demonstrated a very definite area of bone reaction. The diagnosis was established and the patient was placed on light duty with diminished weight-bearing, with subsequent improvement.

CASE II: R. G. E., an 18-year-old Caucasian, was seen two weeks after the onset of right heel pain, which had been increased by the impact of a jump from a 10-foot barrier on the obstacle course several days prior to his reporting for medical attention. This case was the only one with any connection with an episode of trauma, which we believe was but an aggravating factor. Despite physiotherapy for what was originally diagnosed as a tenosynovitis the symptoms increased in severity and four weeks after the original onset of pain a roentgenogram (Fig. 4)

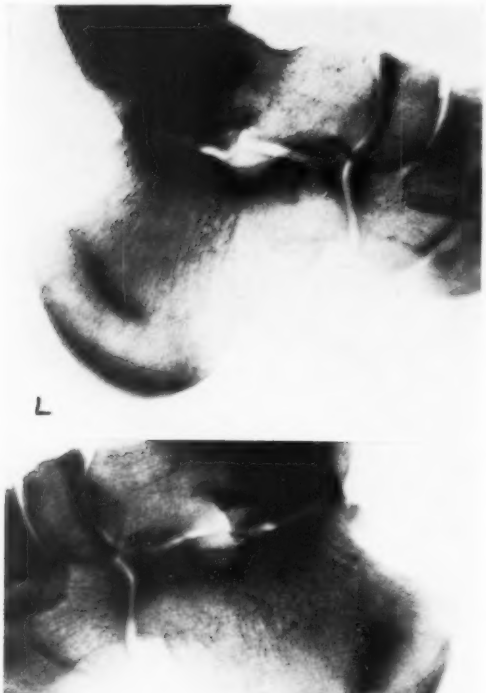

Fig. 6. Right and left os calcis in one of the 3 cases of bilateral involvement.

was taken. A definite area of bone reaction was noted, and a suggestion of cortical defect in the superior margin of the calcaneus was also seen. A repeat examination, two weeks later, demonstrated increased density in the region as well as minimal but definite callus along the superior margin (Fig. 5). Clinical improvement followed light duty with diminished weight-bearing.

CONCLUSIONS AND SUMMARY

Thirteen stress fractures of the calcaneus were encountered in 10 individuals, all Marine Corps recruits. It is felt that the average physician, both civilian and military, is not sufficiently cognizant of this condition. In our experience the number of these fractures observed rose markedly with recognition of its possibility. The condition should be suspected in the presence of pain and swelling of the heel in persons suddenly faced with the stress

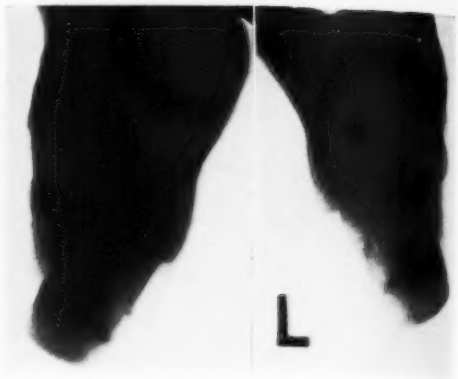

Fig. 7. Axial view of same case as that shown in Figure 6.

of increased pedal activity. It may be recognized radiologically by a linear area of dense bone reaction anterior to the posterior margin of the calcaneus.

NOTE: We acknowledge the encouragement and assistance received from Captain William M. Russell, MC, USN, Depot Surgeon, Marine Corps Recruit Depot, San Diego, Calif. We also thank Mrs. Jeanette Durbin for her invaluable clerical assistance, the Photographic Laboratory at Marine Corps Recruit Depot for the prints used, and the corpsmen of the X-ray Department, Marine Corps Recruit Depot, for their help in this publication.

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ADDENDUM

In the three-month period following submission of this paper 21 additional cases of stress fracture of the calcaneus were discovered. Of these 21 cases, 6 were bilateral. It was further noted that 2 of the original patients with unilateral fractures suffered fractures of the contralateral calcaneus. This gives a total of 42 fractures in 31 individuals, with 38 per cent bilaterality.

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(Pro le summario in interlingua, vider le pagina 414)

Sigmoid Colon and Urinary Bladder in High Fixation: Roentgen Changes Simulating Pelvic Tumor[1]

E. P. ENGELS, M.D.[2]

THE AUTHOR has recently reviewed the histories and roentgenograms of 5 male patients with an unusual appearance of the pelvic colon and, in addition, startling changes in the contours of the urinary bladder and the prostatic urethra. Since the clinical course, bizarre roentgenographic changes, and the presence of a palpable lower abdominal mass may lead to an erroneous diagnosis of a large pelvic neoplasm, a report of these cases is felt justified. For sake of brevity and because of the similarity of the case histories, a composite history suffices.

The patients, 3 white and 2 colored males, were mainly in the later years of life, ranging in age from thirty-eight to eighty years. All but one complained of urinary frequency, backache, and pains over the bladder region occurring episodically over a period of a few months to eight years. A lower abdominal mass, often described as boggy or fluctuant, was felt by some examining physicians and appeared to vary in size from one examination to the next. The patients had low-grade fever and, in 4 instances, reported episodes of gross hematuria and pyuria. Some complained of mild constipation and of occasional rectal bleeding, especially after passage of hard stool.

Cystograms (Fig. 1) showed in each instance an elongated bladder shaped like a gourd or a banana. The bladder appeared to rest unusually high above the symphysis pubis and the prostatic urethra was elongated. In fact, the extreme elongation of this latter structure usually made cystoscopy difficult or impossible. The mushroom-like indentation of the base of the urinary bladder so characteristic of prostatic hypertrophy was not present. (In only one case did digital examination reveal any enlargement of the prostate.)

In the four instances where it was done, sigmoidoscopy disclosed no abnormalities aside from "straightening of the sigmoid colon." Barium enema studies showed the sigmoid colon to rise vertically from the lesser pelvis, usually toward the umbilicus. The colon was distensible, never rigid or fixed, and the post-evacuation mucosal pattern was normal (Fig. 2). In one case, the gas pattern on the plain film revealed the characteristic alteration in the position of the sigmoid colon before a barium enema was administered (Fig. 3).

Extensive adhesions between the urinary bladder, pelvic colon, and anterior abdominal wall were found at laparotomy in 3 patients. The adhesions retracted the viscera upward from the lesser pelvis. In no instance was neoplasm found —only large amounts of fatty tissue about the bladder neck and in the lesser pelvis. The biopsy report was "chronically inflamed fatty tissue," and in 2 instances where open inspection of the urinary bladder and bladder biopsy were done the report was "chronic cystitis" or "cystitis cystica." Prostatic enlargement was not mentioned in the operative records.

Adhesions were not found at one laparotomy. Instead, a thick fibrous cord attached the dome of the urinary bladder and a closely related sigmoid colon to the anterior abdominal wall near the umbilicus. This was felt to represent a remnant of the urachus. In addition, large amounts of fat were present in the lesser pelvis. This patient was admitted for evaluation of a lower abdominal "mass" (bladder), with an eleven-month history of anorexia, recurrent attacks of nausea and vomiting, and occasional passage of narrow mucus-streaked stools. His history differs from

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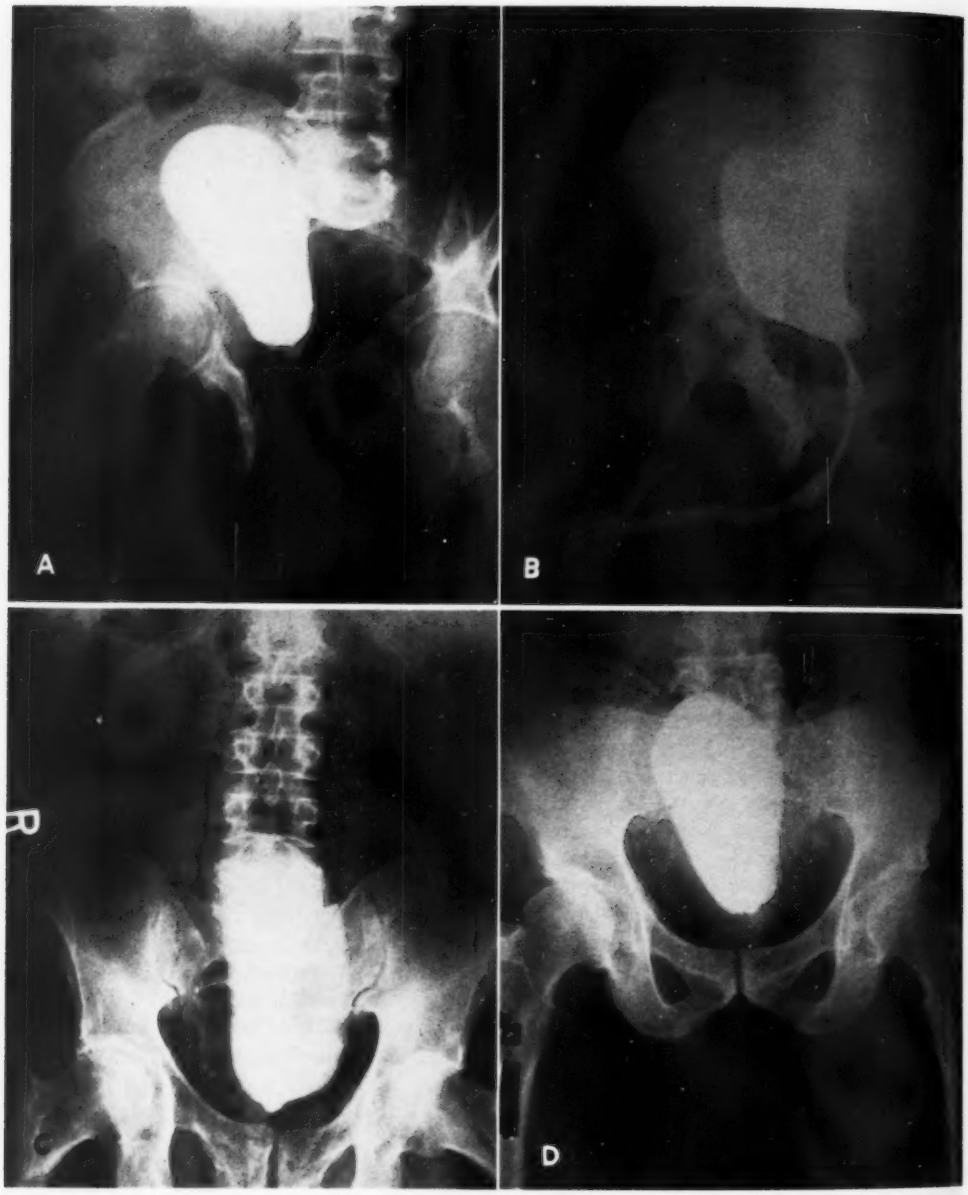

Fig. 1. Cystograms and cystourethrogram, four different cases, showing elevation of gourd-shaped bladder above symphysis and elongation of prostatic urethra (B).

the others in that urinary complaints were absent. A fifth patient was not operated upon. His history suggests that adhesions from chronic urinary tract infections produced the roentgen changes.

Marshak (3) and Pendergrass (4) in recent years have described fairly typical and often diagnostic appearances produced by several benign and malignant processes extrinsic to the pelvic colon. Pessel (5) has demonstrated the late changes produced in the rectum and sigmoid colon by

Fig. 2. Barium enema studies. Cases correspond in sequence to those of Fig. 1. Pelvic colon ascends vertically. Normal muocsal pattern demonstrated on postevacuation film (B). Palpable "mass" outlined by a wire loop in a case where a persistent urachal cord was found at surgery (D).

lymphogranuloma venereum, and Gallagher (2) has noted the stenosing and straightening effect of rectosigmoiditis.

The appearance of the sigmoid colon *in alto fixatum*, briefly described by Schinz (6), is neither considered nor illustrated by the above mentioned authors. His illustration depicts a peculiarly elongated

Fig. 3. Peculiar course of the sigmoid colon shown on the abdominal plain film (later confirmed by barium enema).

sigmoid colon arising abruptly from the lesser pelvis and then passing diagonally toward the splenic flexure, where it seems fixed. This illustration is quite similar to those in the present group of cases.

The histories and clinical findings did not support a diagnosis of lymphogranuloma venereum. The absence of narrowing in the anorectal region on digital examination and on the roentgenograms, the fact that there were no fistulous tracts from the rectum, and lack of rigidity of the colon also seemed to exclude that condition (1). The late and exaggerated results of chronic lower urinary tract infections with accompanying nonspecific perivesical and pelvic inflammatory reaction explain the findings in all but one instance.

SUMMARY

1. Similar bizarre deformities of the sigmoid colon and urinary bladder occurred in 5 male patients of thirty-eight to eighty years. In the 4 cases in which laparotomy was done, fibrous adhesions were found to be responsible for the changes in all save one instance. In this case a persistent urachal cord was found.

2. The roentgen appearances may remotely simulate the changes produced by a large pelvic neoplasm. The clinical findings of recurrent urinary tract infection, constipation, low-grade fever, and a phantom mass (the high urinary bladder) may prompt unnecessary surgery.

ACKNOWLEDGMENT: The author is indebted to Drs. H. Stephen Weens and Albert Rayle, Jr., of the Grady Memorial Hospital, Atlanta, Ga., and to Drs. Ted F. Leigh and Brit B. Gay, Jr., of Emory University Hospital, Emory University, Ga., for their advice and kind permission to use case material.

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Lymphangioma of the Colon

A Case Report[1]

SEYMOUR FISKE OCHSNER, M.D., JOHN E. RAY, M.D., and WALLACE H. CLARK, JR., M.D.[2]

LYMPHANGIOMAS are rarely found in the gastrointestinal tract. A recent report by Arnett and Friedman (1) indicated that only 9 cases had appeared in the English medical literature. Three of these were in the rectum (2–4), whereas the other 6 were in the small intestine. Arnett and Friedman apparently reported the first case to be discovered in the colon. The following case is therefore believed to be the second. It is also, to our knowledge, the first case of polypoid lymphangioma of the colon to be reported.

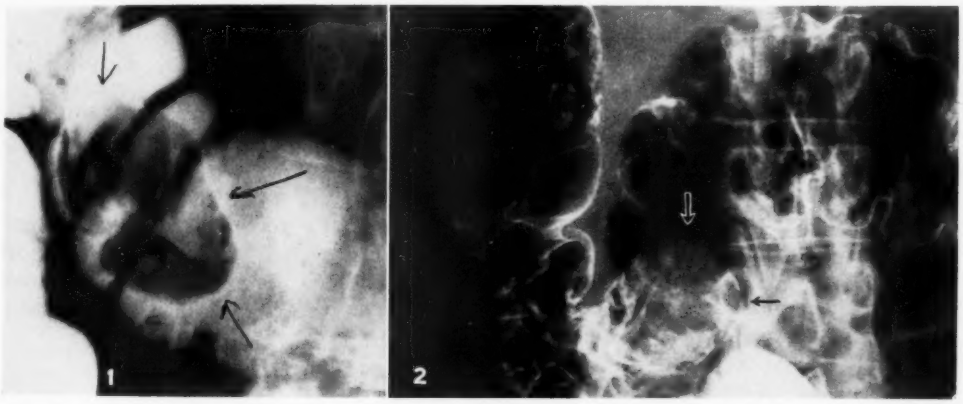

Fig. 1. Large, smooth, radiolucent filling defect in transverse colon, demonstrated in spot roentgenogram.
Fig. 2. Persistent filling defect in air-contrast roentgenogram.

REPORT OF CASE

A white housewife, 51 years old, was first seen at the Ochsner Clinic in July 1956. A general examination disclosed obesity, some indigestion, and electrocardiographic evidence of myocardial disease. A barium-enema examination of the colon on July 30, 1956, was unsatisfactory because of retained fecal material but a notation was made that "polyps are not excluded." In the absence of specific complaints, the examination was not repeated. Treatment was symptomatic.

In June 1957, intermittent severe pains developed in the right upper abdominal quadrant. Roentgen examination elsewhere showed what seemed to be polypoid lesions in the transverse and descending segments of the colon. The patient returned to the Ochsner Clinic for additional studies and treatment. Results of a barium and air contrast type of roentgen examination on July 5, 1957, were considered negative but, in view of the previous findings elsewhere, re-examination was requested by the radiologist. On July 10, 1957, when the colon had been better prepared for examination, an ovoid, pedunculated, polypoid type of mass measuring 5 by 3.5 cm. was discovered in the transverse colon near the hepatic flexure. The lesion was discrete, was not fixed, and had smooth margins (Figs. 1 and 2). Its smooth contours and relative radiolucency suggested that it might be a lipoma.

On July 18, 1957, the tumor was removed by segmental resection of the transverse colon. Grossly, it was pale yellow, soft, smoothly outlined, and pedunculated, measuring 6 × 4 × 2 cm. (Fig. 3). Its external appearance was that of a submucosal lipoma, but on section small, multiloculated, cystic areas about 0.5 cm. in diameter could be seen. These contained a clear, straw-colored fluid. The mucosal covering was not ulcerated. The microscopic picture was typical of a lymphangioma. Lymphatic channels of varying size involved the lamina propria, the muscularis mucosae, and the submucosa but did not extend into the muscularis (Fig. 4). Recovery was prompt and the patient is well.

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Fig. 3. Resected intestinal segment. The polypoid tumor was yellow. Its cut surface was homogeneous except for cystic bases.

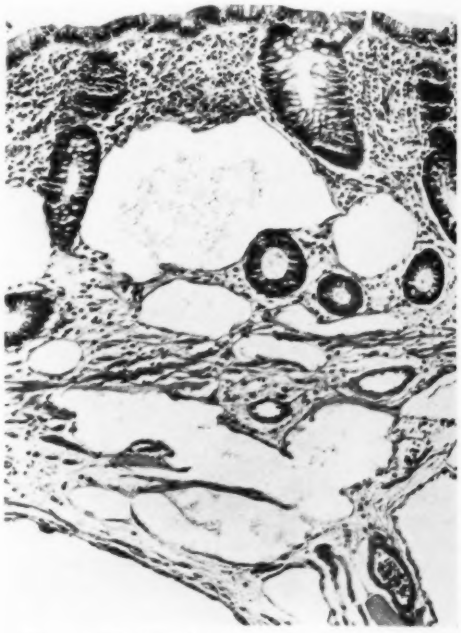

Fig. 4. Microscopic section of resected tumor. The dilated lymphatic spaces are seen in the lamina propria and extending through fragments of the muscularis mucosae into the submucosa (×100).

DISCUSSION

The first recorded case of lymphangioma of the colon was an intramural lesion which proved difficult to demonstrate by roentgenologic means because of its variable contours and cystic nature. Arnett and Friedman decided that demonstration of a pedicle should exclude a diagnosis of lymphangioma, but this hypothesis has proved incorrect. In our case the tumor was circumscribed and definitely pedunculated. In this respect it resembled the polypoid lymphangioma of the rectum reported by Emmert (3). Lesions with a similar pathologic basis, lymphatic cysts of the transverse colon, have been recorded by Koenig *et al.* (5) and Higgason (6).

This case points out sharply the obscuring effects of fecal material in the colon and the necessity for the roentgenologist to request an opportunity for re-examination in instances of equivocal findings or unusual suspicion of disease. If the colon is not cleansed of fecal débris, it may be impossible to be certain that no polypoid lesion is present.

SUMMARY

A case of lymphangioma of the colon has been presented. It is believed to be the second to be recorded in the literature. A pedunculated tumor was visualized roentgenologically following adequate preparation of the colon and was successfully resected.

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SUMMARIO IN INTERLINGUA

Lymphangioma Del Colon

Es presentate un caso de lymphangioma del colon. Es exprimite le opinion que il se tracta del secunde tal caso notate in le litteratura. Un tumor pedunculate esseva visualisate roentgenologicamente in un femina de cinquanta-un annos de etate post un preparation adequate del colon. Le tumor esseva resectionate a bon successo.

SUMMARIO IN INTERLINGUA

Colon Sigmoide E Vesica Urinari In Fixation Alte: Alterationes Roentgenographic, Simulante Tumor Pelvic

(*Pagina 419*)

Bizarre deformitates del colon sigmoide e del vesica urinari esseva observate similemente in 5 patientes mascule de trenta-octo a octanta annos de etate. In le 4 casos, in le quales un laparotomia esseva effectuate, il esseva constatate que adhesiones fibrose esseva responsabile pro le alterationes in omnes con un exception. In le caso exceptional, un persistente uracho esseva trovate. Le apparentia roentgenographic simula distantemente le alterationes producite per un grande neoplasma pelvic. Le constatationes de recurrente infectiones del vias urinari, de constipation, de basse grados de febre, e de un pseudomassa (le alte vesica urinari) pote ducer a un operation chirurgic que non es necessari.

Familial Basal Ganglia Calcification[1]

Case Diagnosed by Displacement of Calcification in the Basal Ganglia

A. J. PALUBINSKAS, M.D.,[2] and HUGH DAVIES, D.M. (OXON.)[3]

BILATERAL SYMMETRICAL calcification in the basal ganglia of the brain is rare. When it occurs, it is most commonly associated with hypoparathyroidism, either idiopathic or following thyroidectomy (2, 3, 9). Less frequently such calcification has been discovered in several members of the same family and their blood relatives, none of whom show evidence of hypoparathyroidism either clinically or by ordinary blood calcium and phosphorus studies (1, 4, 6, 11).

The following case summary describes an instance of familial basal ganglia calcification in which routine determinations of blood calcium and phosphorus were within normal limits. A most unusual feature of this case is the unexpected roentgen finding of displacement of the calcified basal ganglia on one side. This permitted the diagnosis of a space-occupying intracranial lesion to be made from examination of the plain films of the skull alone.

J. M., a 55-year-old white male, was admitted to the National Hospital, Queen Square, London, under the care of Mr. Harvey Jackson. During the last four months prior to admission the patient had shown progressive loss of memory and reasoning ability, deterioration of visual acuity, weakness of the right arm and hand, deafness on the right side, and speech difficulties. There had been involuntary movements of the right arm for three months and headaches for two months, but no respiratory complaints, convulsions, or symptoms suggesting tetany. The patient had smoked 10 to 15 cigarettes a day for most of his adult life. Prior to his admission he had been examined at another hospital, where skull roentgenograms had shown extensive intracranial calcification. His blood calcium at that time was found to be 10.4 mg. per cent.

The patient was a healthy-looking adult male in no apparent distress, who smiled amicably during the entire examination but was confused and disoriented. He had a severe memory defect, and there appeared to be gross intellectual deterioration. He was dysphasic, with slow, hesitant, and sometimes unintelligible speech.

Fig. 1. Note the curvilinear character of the calcification above the main calcific deposits in the basal ganglia. This is apparently due to extension of the calcification into the elements of the internal capsule. The arrow indicates the dense calcification in the dentate nuclei of the cerebellum.

Visual acuity was J.14 on both sides. The right pupil was larger than the left, and funduscopic examination revealed bilateral papilledema. In addition to a right-sided lower facial weakness, there was a right-sided spastic hemiplegia, and both plantar responses were extensor. All fingers showed marked clubbing.

Routine examinations of the blood and urine were normal, and the Wassermann reaction was negative. The serum calcium was 9.6 mg. per cent and the serum phosphorus 4.6 mg. per cent. Blood urea, alkaline phosphatase, and acid phosphatase determinations were all within the normal range. No attempt was made to perform calcium or phosphorus balance studies.

The patient was unco-operative, and the initial chest roentgen study was technically unsatisfactory. Skull films revealed extensive bilateral calcification in the basal ganglia and the dentate nuclei of the cerebellum (Fig. 1). The calcification in the left basal ganglia was displaced medially (Fig. 2).

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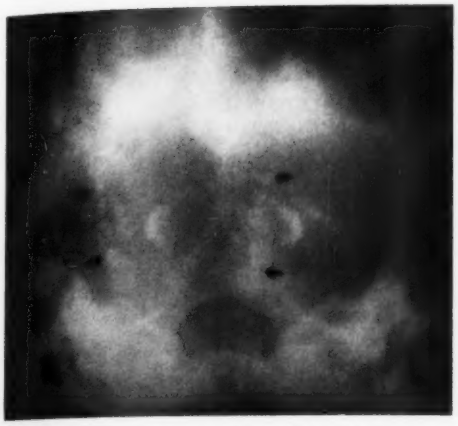

Fig. 2. Arrows indicate the position of the basal ganglia, that on the patient's left side being displaced considerably toward the midline. The comma and reversed comma-shaped densities represent calcification in the dentate nuclei.

Ventriculography confirmed this displacement by a space-occupying mass.

A diagnosis of intracranial metastases from a primary malignant focus in the lung was made, and biopsy revealed the intracranial lesion to be a secondary carcinoma. Some of the sections which were removed showed capillary calcification of gray matter.

The patient's condition gradually but progressively deteriorated. Prior to his death, repeat chest films demonstrated opacities in the periphery of the left upper lobe and in both hilar areas.

At necropsy, the lesion in the left lung was found to be a primary bronchial carcinoma with bilateral involvement of the hilar nodes. No abnormal parathyroid glands were found.

Examination of the brain revealed the midline structures displaced toward the right by a mass of secondary tumor tissue within the deep white matter of the central portion of almost the whole of the left parietal lobe, extending from the coronal level of the lateral geniculate body to a point 5 cm. from the occipital pole. There was gross calcareous replacement with hard masses of rock-like material affecting most of the globus pallidus and the medial aspect of the putamen bilaterally, as well as most of the dentate nuclei.

During the course of the patient's hospitalization, skull films of his only child, a married daughter, were obtained (Figs. 3 and 4). These revealed bilateral symmetrical calcification of the basal ganglia as well as several small scattered foci of calcification in the anterior half of the brain. No calcification in the dentate nuclei could be recognized. The daughter was completely asymptomatic and unfortunately no biochemical studies of her blood could be obtained. Attempts to study other members of the family were unsuccessful.

Fig. 3. Calcification of the basal ganglia in the patient's daughter. Note the small flecks of calcification scattered in the brain tissue anterior to and above the basal ganglia.

Fig. 4. Calcification of the basal ganglia in the patient's daughter. The roentgen view is comparable to that in Fig. 2 and shows calcification in the normally-positioned basal ganglia. No cerebellar calcific deposits were visible roentgenographically.

DISCUSSION

The relationship of symmetrical calcification in the basal ganglia of the brain to hypoparathyroidism and pseudohypoparathyroidism has been well emphasized in recent medical and radiological literature (5, 7-10). Calcifications in the dentate nuclei of the cerebellum and elsewhere in the brain are not infrequent concomitants.

Symmetrical calcification of the basal ganglia roentgenographically indistinguish-

able from that seen in any of the forms of hypoparathyroidism has been discovered in members of family units as well as in certain of their blood relatives. In some reports there has been a history of either lifelong or relatively late onset of neurological and/or mental deficiencies. In other instances there has been evidence of latent hypoparathyroidism or blood calcium and/or phosphorus abnormalities on careful biochemical balance studies. Some of the cases reported, however, like the one described above, showed no evidence of clinical or biochemical hypoparathyroidism, but complete calcium and phosphorus balance studies were not usually performed.

Similar symmetrical calcification in the basal ganglia has been seen, although rarely, in toxoplasmosis and has been noted by the authors in a patient with radiological evidence of Sturge-Weber's syndrome.

Postmortem examinations of brains with such intracranial calcification are infrequent. The underlying process appears to be a perivascular deposition of calcium about small vessels in brain tissue, but calcium aggregations free in the nervous tissue have been reported.

That a single fundamental abnormality is responsible for the calcification seen in all the above-mentioned entities seems unlikely. It is not improbable, however, that certain cases of asymptomatic basal ganglia calcification will be found on careful balance studies to have some form, albeit latent, of parathyroid hypofunction or dysfunction, or that some of these patients, even if found to have no parathyroid dysfunction, will in later years show neurological and/or intellectual impairment.

SUMMARY

An unusual instance of a space-occupying intracranial lesion diagnosed on plain films of the skull by displacement of calcification in the basal ganglia has been presented. Routine determinations of the blood calcium and phosphorus levels were normal, and there was no clinical evidence of hypoparathyroidism.

The healthy daughter of the patient was found to have similar intracranial calcification. Both were thought to be examples of idiopathic familial basal ganglia calcification but, in the absence of complete balance studies, this interpretation must be regarded as convenient rather than precise.

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NOTE: The authors express their appreciation to the Medical Committee of The National Hospital, Queen Square, and to Mr. Harvey Jackson for permission to publish material from the hospital records of this patient.

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SUMMARIO IN INTERLINGUA

Calcification Familial De Gangliones Basal

Es presentate un caso inusual de lesion cranial spatial, diagnosticate in pelliculas conventional del cranio super le base de displaciamento de calcification in le gangliones basal. Determinationes routinari del calcium e del phosphoro del sanguine monstrava nivellos normal. Esseva notate nulle signo de hypoparathyroidismo.

Le filia del patiente se trovava in bon sanitate, sed un simile calcification intracranial esseva constatate in illa. Esseva opinate que il se tractava in ambe casos de idiopathic calcification familial del gangliones basal, sed in le absentia de complete studios de balancia, iste interpretation debe esser considerate como convenibile plus tosto que como precise.

NATIONAL COMMITTEE ON RADIATION PROTECTION AND MEASUREMENTS

On April 15, 1958, the NCRP issued a statement on the new maximum permissible radiation exposures to man. These were in line with the 1956 recommendations of the ICRP. The statement of April 15 was also issued as an addendum to *Handbook 59*, since this is the source of primary NCRP philosophy on permissible exposure. This addendum is printed and bound into the issues of *Handbook 59* now available at the Government Printing Office.

In the meantime, several of the other handbooks (H52, H54, H60, and H61) are under active revision—partly for normal up-dating and partly to bring them into line with the new values for MPD. The current versions will be supplied until the revisions are available. To assist the user of current handbooks, copies of the addendum to *Handbook 59* are being supplied with most of them as they are issued by the Government Printing Office.

It is hoped that revised versions of *Handbooks 54, 60,* and *61* will be completed within the next six months. Revision of *Handbook 52*, "Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water," is nearing completion. This program has been carried on concurrently with the corresponding committee of the ICRP; both are under the chairmanship of Dr. K. Z. Morgan.

Subcommittee No. 1 on "Permissible Dose from External Sources" is being reorganized, not as a subcommittee but as the prime technical committee of the NCRP for the development of basic philosophy. This is necessary since the recommendations of this committee provide the primary guidance for most of the other activities of the NCRP. Its new Chairman is expected to be Dr. Simeon Cantril, with Dr. H. M. Parker as Vice-Chairman. In addition to members of the old Subcommittee 1, new members will include chairmen of appropriate subcommittees of the NCRP.

Subcommittee 10 on "Regulation of Radiation Exposure Dose" is now reorganized under the chairmanship of W. A. McAdams of General Electric Company. The Subcommittee has been making excellent progress on the revision of Appendix B of *Handbook 61* giving the suggested regulations for state or national use. The membership of the reorganized subcommittee is as follows:

Working Group

Paul Hodges	University of Chicago
Jan Lieben	Pennsylvania Department of Health
E. P. Pendergrass	University of Pennsylvania Hospital
J. A. Reynolds	Picker X-Ray Corp.; Waite Manufacturing Division
L. Rogers	U. S. A. E. C.
J. G. Terrill, Jr.	U. S. Public Health Service

Advisory Group

W. H. Eells	Coordinator of Atomic Development Activities, State of Ohio
G. C. Frampton	University of Illinois
L. M. Hydeman	U. S. A. E. C.
M. Kleinfeld	N. Y. Department of Labor
L. Manning	U. S. Department of Labor
R. R. Newell	Naval Radiological Defense Laboratory
F. A. Norton	Southern Regional Advisory Council on Nuclear Energy
M. Stein	U. S. Public Health Service
E. Dale Trout	General Electric Company

Subcommittee 14 on "Permissible Exposure Doses under Emergency Conditions" is now operating under a new chairman, Dr. George Leroy. A great deal of effort has been put into this activity over the past three years and the difficulty in completing its report is more a matter of presentation than of the basic philosophy involved. Interim recommendations of the subcommittee are already in use by the O. C. D. M. for planning purposes. The membership of the subcommittee is as follows:

Members

George V. Leroy	Billings Hospital, Chicago
H. L. Andrews	U. S. Public Health Service
H. Blair	University of Rochester
G. Casarett	University of Rochester
G. Dunning	U. S. A. E. C.
E. Green	Roscoe B. Jackson Memorial Laboratory
R. Hasterlik	Argonne Cancer Research Hospital
L. S. Taylor	National Bureau of Standards
E. G. Williams	U. S. Public Health Service

Consultants

C. B. Braestrup	Francis Delafield Hospital, New York
R. F. Brown	University of California, School of Medicine
J. Bugher	Rockefeller Foundation
A. H. Dowdy	UCLA School of Medicine
L. H. Garland	San Francisco, California
L. H. Hempelmann	Strong Memorial Hospital
R. D. Huntoon	National Bureau of Standards
H. M. Parker	General Electric Company
G. A. Sacher	Argonne National Laboratory
R. S. Stone	University of California
Shields Warren	New England Deaconess Hospital

EDITORIAL

A Critique of Roentgen Interpretation[1]

Presumably, the President of the Radiological Society of North America should be old and wise, and thus able to give advice to his colleagues. This responsibility has weighed heavily on my conscience, for I do not consider myself very old as yet, and certainly I cannot lay claim to wisdom with any feeling of confidence. Nevertheless, I would take this opportunity to re-evaluate some ideas concerning the practice of roentgen diagnosis, and particularly our procedures of interpretation.

That roentgen diagnosis is still a dynamic expanding field of endeavor, a productive outlet for brains and energy, is attested by the last Program of the Radiological Society of North America, and by many others offered in this division of Radiology. The opportunity to improve our diagnostic resources is still with us to a superlative degree. Spectacular new developments occur almost from day to day, so rapidly indeed that it is difficult to keep abreast of the new procedures. Much still remains to be done so to improve our methods that the most minimal disease process will be detectable, and those segments of the anatomy now relatively inaccessible to roentgen methods will be made visible. But diagnosis can be improved in many respects without any additions to our armamentarium, with the conventional, presently available roentgenogram itself.

Ours is a technological age, in which the physical sciences have advanced so much more rapidly than our thinking processes that many serious students of philosophy are greatly concerned about the possibility of imminent disaster. This trend is best exemplified by the development of new and more terrifying weapons without a corresponding development in brain power, vision, and the understanding of how to use our technological power for the benefit, rather than for the destruction, of mankind.

In a small way, a somewhat similar situation exists in the field of radiology. All around us are new technics, more and more complex, and at the same time more and more revealing of the anatomical, pathological, and physiological constitution of the body. We are now able to see structures, to delineate pathological processes never before exhibited in the living individual. I wonder, however, whether these superb technics do not tend to minimize, or even to nullify, the importance of our thought processes, of our imagination, of our brains. Do we resort too quickly to our hands without first using our heads?

Basically, there are three major steps in roentgen interpretation. The first is the distinction of one structure from another, a process affected in part by radiographic technic and by optics physiology. It has been dealt with extensively in recent years, notably by Tuddenham and his associates. The second is the determination whether a shadow represents a normal structure, a normal variation, or a real abnormality; that is, the detection of a disease process. In essence, this is a problem in differential diagnosis, the separation of the normal from the abnormal. The third follows: that is, the identification of the nature of the abnormality. For this last, particularly, numerous other diagnostic procedures are available. But in many cases the identification of the disease, as well as

[1] Presidential Address, delivered before the Radiological Society of North America at its Forty-fourth Annual Meeting, Chicago, Ill., Nov. 17, 1958.

its detection, lies within the capacity of the roentgen examination itself.

Almost everyone will agree that we have not yet exploited the full potential of the conventional roentgenogram. We are still guilty of many errors of omission and commission. Some errors and gaps are intrinsic in the nature of roentgen examination and probably can never be eradicated. Some are the natural result of human fallibility, for there is a large element of judgment in all roentgen diagnosis. But errors caused by failures in our procedures of interpretation are largely correctible. More and more they come to light in our follow-up studies as we increasingly review, in retrospect, past examinations.

Two major criticisms of our present procedures bear upon these correctible errors. The first concerns the dreadful speed with which the roentgenogram is often interpreted. The increasing number of radiologists in this country seems to be more than matched by the increased amount of work which they are called upon to do. Partly as a result of this, and partly, I am afraid, as a result of pernicious habit, the time spent in the consideration of the individual roentgenogram is far too short when compared to the importance it has for the fate of the patient. There are, of course, great variations. At the extreme, we find minifilms being interpreted at the rate of 100 or even 200 per hour, one of the reasons, I am certain, that this procedure has often proved to be ineffective. Obviously, in the case of conventional roentgen interpretation, such speeds are never attained. But in large institutions, particularly those training many radiologists, a great emphasis on speed is common. Why should we devote so much less time to a roentgenogram than the internist devotes to his physical diagnostic procedures? Consider the amount of time consumed in doing an adequate physical examination of the chest and compare it with the time used in the study of a series of chest films with or without fluoroscopic examination. The ratio will often be ten to one for the time consumed and one to ten for the information obtained. Perhaps it is well that the study of films requires much less time than that required by the cumbersome methods of physical examination. I am confident, however, that casual, rapid interpretation leads to grave errors and produces a stultification of the roentgen procedure.

Despite the importance of the technical and optical factors which affect film interpretation, in the final analysis the most important factor in the detection of lesions is the competence of the individual doing the interpreting and his ability to give detailed attention to every portion of the roentgenogram. Regardless of how experienced, how facile, how able, the radiologist may be, this cannot be accomplished in ten seconds or in one minute. I have demonstrated to my own satisfaction that many of our most serious errors result from a failure to concentrate upon the roentgenogram for a reasonable period of time. Films should be examined, appraised, put aside, and re-examined again a short time later. Repeated study of the same films, especially those which are somewhat complex, often brings to light findings at the second, third, or fourth look which were not apparent at the first observation.

At times, the physician untrained in radiology is relatively successful in the interpretation of the roentgenogram. Because of previous information, he knows what he ought to find and concentrates his attention upon a specific area, searching until he discovers an abnormality, no matter how small. The radiologist, without knowledge of the patient's complaint or wishing to ignore the history, may inspect the film in routine fashion and miss the same lesion completely. It goes without saying that the physician who expects to find something often finds it when it is not there, and I would not recommend this as a good method for the detection of abnormalities in the roentgenogram. But it does illustrate the fact that abnormal shadows may be present in the roentgeno-

gram and escape observation until attention is directed to a specific area. I have tested this repeatedly with numerous observers. Either because of the blind spot sometimes present when surveying a large film, or because of simple inattention, or because of distraction by an obvious process which may be of little clinical importance, small lesions are missed on the first examination, whereas on re-examination they become perfectly apparent. This is not really a matter of optics—not at all—it is related to careful observation and concentration.

The importance of time-consuming, often boring, detailed attention to the individual roentgenogram—no matter how asymptomatic the patient or how normal the superficial appearance—has been greatly enhanced in recent years. With the increase in our economic well-being and the great elevation in living standards has come an increasing demand for the diagnosis of ailments when they are still presymptomatic. I am not referring to mass surveys, but rather to the patient with minimal or no symptoms who wishes to be reassured of his normal state or, if disease is present, to find it in its incipiency rather than after it is fully developed. Such situations are becoming more and more frequent in radiological practice. In them, the detection of minimal lesions, their differentiation from the normal, becomes a serious problem. Anyone who has studied films in retrospect will appreciate how easy it is to miss, in the presymptomatic stage, lesions which become readily apparent, once attention is directed to them by the development of symptoms or by an increase in size.

So far I have been referring to the process of detection of an abnormality. The second criticism is that we fail to use the fullest potential of our imagination, our clinical experience, our considered judgment in the identification of a disease process. Reluctant to commit ourselves to a specific diagnosis, we too often take refuge in elaborate descriptions, talk of shadows, and multiple diagnoses. In the differential diagnosis of a discovered abnormality, we should bring our thought processes into fullest play, affected as they are by that superior knowledge of roentgen interpretation which makes the roentgen diagnostician a specialist. Prolonged study of the roentgen findings, careful logical analysis, and hard thinking may frequently produce a reasonably exact diagnosis without resort to added roentgen methods or other diagnostic procedures.

Almost too frequently, the roentgenogram exhibits findings which are so characteristic that the opportunity to make a spectacular, extremely rapid diagnosis is irresistible. One look, and the exact nature of the process becomes apparent. Confronted by the dramatic denouement of which the radiologist is capable, the physician, who has sweated for hours over the details of the history, a laborious physical examination, and the analysis of extensive laboratory data, is often overwhelmed. Unfortunately, the temptation to indulge in the rapid look and the even more rapid conclusion is strong, and too often yielded to routinely. I would urge study and re-study, weighing all the possibilities, giving thought to all the roentgen studies, both old and new. Let us take more time, do fewer cases, use the conventional roentgenogram to its fullest extent, before undertaking more elaborate technics. By this means, we can keep roentgen diagnosis a dignified, intellectual, carefully thought-out procedure in accord with its importance in the conquest of disease.

LEO G. RIGLER, M.D.

IN MEMORIAM

"Death be not proud . . . for those whom thou thinkest thou dost overthrow die not."—Ben Jonson

C. Edgar Virden, M.D.

1895–1958

It is with mixed emotion that I undertake to write this obituary for our friend and colleague, Dr. C. Edgar Virden: a strong sense of pride because I was privileged to know him personally; a stronger sense of humility when I think of his brilliant accomplishments.

Charles Edgar Virden—"Spike" to those who knew him well—was born on April 2, 1895, in Kansas City, Missouri, where he received his early schooling. He obtained his A.B. degree from the University of Missouri and in 1920 was graduated from the Northwestern University School of Medicine. After internships at Chicago Lying-in Hospital and St. Joseph's Hospital in Kansas City, he entered the general practice of medicine in Norton, Kansas. Fortunately, however, this did not wholly satisfy him, and he became interested in radiology. After training in this specialty under Dr. Edward Blaine in Chicago, he joined the faculty of the University of Kansas Medical School under Dr. J. L. McDermott and was later elevated to the position of Assistant Professor of Radiology. He was also Chief of the Radiological Services, St. Joseph's Hospital; Consultant to the U. S. Public Health Service in Radiology; Director of the Tumor Clinic, Parsons, Kansas.

Dr. Virden's tireless vigor and dedication to medicine soon found him in a host of responsible offices. He was President of the Jackson County Medical Society (1945), of the Missouri State Medical Society, of the Missouri Division of the American Cancer Society, and of the Kansas City Southwest Clinical Society. At a national level he served the Radiological Society of North America as Chairman of the Refresher Course Committee for a number of years. In 1952 he was elected to the Board of Directors of the Society and became its Chairman in 1955. In 1957 he was made President. The American College of Radiology also appreciated Dr. Virden's abilities. He served on numerous committees of the College, was a member of the Board of Chancellors, Chairman of the Board, and in 1950 President of the College. Recognition of his services came in the form of many honors and in the posthumous award of the Gold Medal of the American College of Radiology.

Dr. Virden was a Fellow of the Inter-American Congress of Radiology and held membership in the American Geriatric Society, Kansas City Academy of Medicine, and numerous civic and social clubs. As a citizen of his community he joined wholeheartedly in any project where his services were needed.

On October 3, 1958, Dr. Virden died suddenly in Washington, D. C. He is survived by his lovely wife, Margaret, who was a constant companion, consultant, and inspiration to him; by two children, Herbert, who is following his father's footsteps as a radiologist, and Virginia; and by six grandchildren. Dr. Virden will be sorely missed by his family, friends, and colleagues. He will be remembered for his inspirational and dedicated life, his warm sincerity, and the graciousness and humor for which he always found time throughout a full and fruitful career.

JOHN W. WALKER, M.D.

C. Edgar Virden, M.D.
1895–1958

IN MEMORIAM

Warren W. Furey, M.D.

1898–1958

The sudden death of Warren W. Furey early on the morning of Nov. 19, 1958, during the Forty-fourth Annual Meeting of the Radiological Society of North America, came not only as a shock to those in attendance upon the meeting, but was keenly felt throughout the ranks of American Medicine and Radiology. To those who had enjoyed the privilege of his friendship the loss was a stunning blow.

Warren W. Furey was born in Chicago on Jan. 8, 1898, and except for a year in Washington State spent his life in that city. Some stimulus in his early days led him to the study of medicine and he was graduated in 1923 from Northwestern University Medical School. After a brief interlude in general practice in Everett, Washington, he returned to Chicago and entered the Department of Radiology in Mercy Hospital, where he had served his internship. He became Director of the Department in 1944 and in the same year was made Assistant Clinical Professor of Roentgenology in the Stritch School of Medicine, Loyola University, having been on the faculty in one capacity or another since 1927. He was also chief radiologist in the Little Company of Mary Hospital in Evergreen Park, Illinois, and radiological consultant at Lewis Memorial Maternity Hospital.

Dr. Furey's interest in organized medicine led to his appointment to numerous positions of responsibility in which his influence was strongly felt. He was a trustee and subsequently President (1942–44) of the Chicago Roentgen Society and was active also in the councils of the Chicago Medical Society, of which he became President in 1947. From 1948 to 1957 he was a member of the House of Delegates of the American Medical Association. In 1955 he became a member of the Council on Constitution and By-Laws of that organization, and in June 1958 was elected to the Board of Trustees. He was President of the Illinois Medical Service (Blue Shield) from 1951 to 1955 and subsequently Secretary and a member of the Executive Committee of the National Blue Shield Commission. At the time of his death he was President of the Tuberculosis Institute of Chicago and Cook County. He was a member of the American Roentgen Ray Society and of the American Radium Society.

Dr. Furey became a member of the Radiological Society of North America in 1933 and was its President in 1950. He was awarded the Gold Medal of the Society in 1954. He was successively Treasurer, Chancellor, and President (1955) of the American College of Radiology, which in 1959, by unanimous action of the Board of Chancellors, bestowed upon him posthumously its Gold Medal. In 1955 he received the Alumni Medal of Loyola University and the following year an alumni citation from Northwestern University.

Prominent in Catholic circles, Dr. Furey was elevated to the rank of Knight of St. Gregory by the late Pope Pius XII. During his Requiem Mass it was said of him that "he was firmly fastened to the ground while his head was in the clouds of honors, success, and laurels . . . . Though fit to walk with kings, he never lost the common touch." The full import of these words is best appreciated by those whose association with him was closest.

Surviving Dr. Furey are his devoted wife, Veronica; his daughters Rosemary and Virginia (Mrs. Lawler); and sons, Warren III, now a medical student at Northwestern University, and Edward.

JOHN H. GILMORE, M.D.

Warren W. Furey, M.D.
1898–1958

IN MEMORIAM

Raymond Ray Lanier, Ph.D., M.D.

1914–1958

Radiology lost one of its younger outstanding members in the passing of Raymond R. Lanier, M.D., Nov. 24, 1958, in the Holyoke Hospital, following a jeep accident while on a pheasant-hunting trip near Holyoke, Colorado.

Dr. Lanier was a physician, radiologist, anatomist, scientist, sportsman, conservationist, and friend to all who knew him. He was born in Louisville, Kentucky, in 1914, the son of the late Myrtle Stephens and Rev. R. R. Lanier, and was educated at the University of Richmond (B.A. 1935), Duke University, Washington University (Ph.D., 1939), and Washington University School of Medicine (M.D., 1944). After serving his internship and residency in radiology at the University of Chicago Clinics, he held the ranks of Instructor and Assistant Professor of Roentgenology in that institution for two years. He went to the University of Colorado as Professor of Radiology and Head of the Department in 1950, a position which he held at the time of his death. Dr. Lanier served two years in the Army Medical Corps in Alaska following World War II.

Dr. Lanier was a Fellow of the American College of Radiology, and a member of the American Medical Association, Colorado State Medical Society, Arapahoe County Medical Society, Radiological Society of North America, Rocky Mountain Radiological Society, Colorado Radiological Society (President 1956), Colorado Society of Nuclear Medicine, American Association of Anatomists, American Association of Physical Anthropologists, and American Association for the Advancement of Science. He was active as a committeeman in a number of these organizations, especially in radiology.

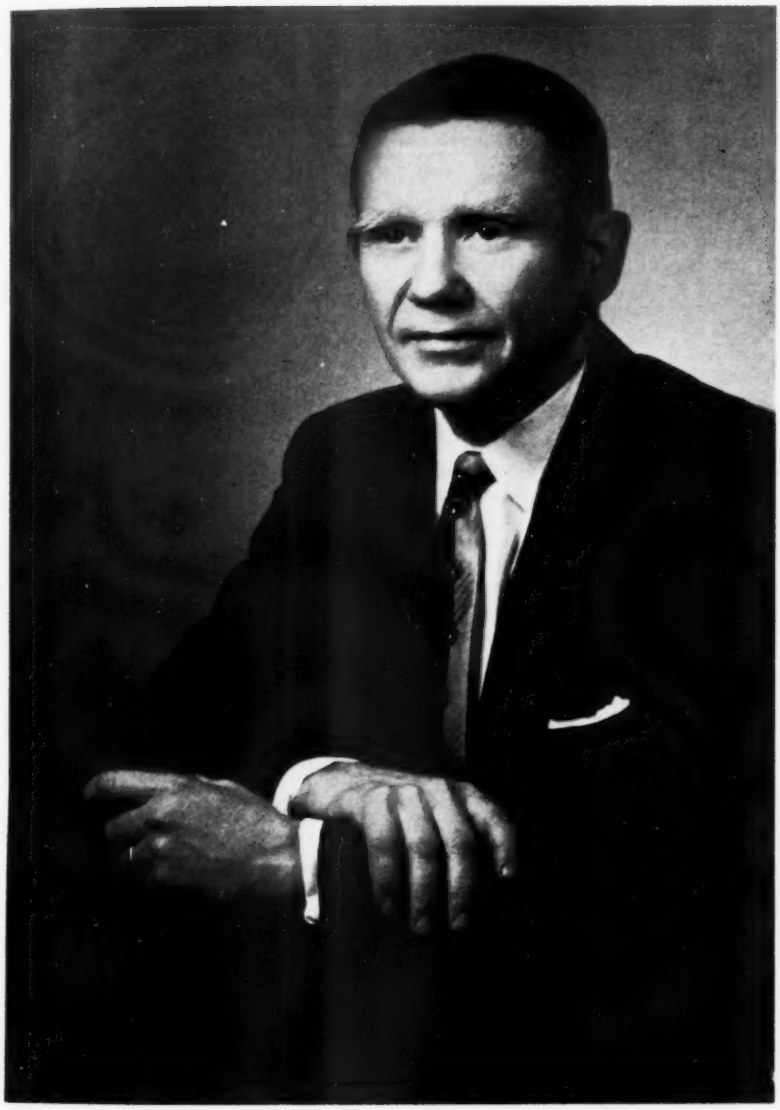
Dr. Lanier had just returned from Lima, Peru, where he presented a paper on "Studies of Effects of Radiation Beam Qualities on Human Cells Grown in Tissue Culture" before the Sixth Inter-American Congress of Radiology. This study was one of several by Dr. Lanier and Dr. Theodore Puck, the first man to grow human cells. Their work was expected to become a contribution to the fight against cancer.

At the time of his death, Dr. Lanier was chairman of the Committee on State Parks and Wilderness for the Colorado Division of the Izaak Walton League of America. He was an enthusiastic sportsman and outdoorsman, spending much of his time in work for conservation. He testified on behalf of the Wilderness Bill at the hearing held in Albuquerque, New Mexico, on November 14.

He will long be remembered for his remarkable ability to get to the heart of the matter after others had spent hours and numerous words to reach a conclusion.

He is survived by his wife, Virginia Singleton (who is a physician), and three children, a daughter, Ellen Frances, and two sons, Robert Lewis and Keith Singleton. Ray's modesty and kindness endeared him to a wide host of acquaintances and all held him in high esteem. These and his close friends join the family in mourning for the passing of a fine gentleman and radiologist.

JOHN S. BOUSLOG, M.D.



Raymond Ray Lanier, Ph.D., M.D.
1914–1958

GREATER MIAMI RADIOLOGICAL SOCIETY

The newly elected officers of the Greater Miami Radiological Society are: President, Richard D. Shapiro, M.D., Miami Beach; Vice-President, Andre S. Capi, M.D., Hollywood; Secretary-Treasurer, George Daurelle, M.D., Jackson Memorial Hospital, Miami. The meetings of the Society are held on the third Wednesday of each month at 8:00 P.M., at Jackson Memorial Hospital.

KENTUCKY RADIOLOGICAL SOCIETY

At a recent meeting of the Kentucky Radiological Society, the following officers were elected: President, Gerald M. Peterson, M.D., Louisville; Vice-President, W. Leroy Boswell, M.D., Lexington; Secretary-Treasurer, Robert H. Akers, M.D., VA Hospital, Louisville 2.

MISSISSIPPI RADIOLOGICAL SOCIETY

The newly elected officers of the Mississippi Radiological Society, all of Jackson, are: President, James M. Packer, M.D.; Vice-President, Robert R. Surratt, M.D.; Secretary-Treasurer, Bernard T. Hickman, M.D., University Medical Center, Jackson. The Society meets on the third Thursday of each month at 6:00 P.M., at the Edwards Hotel, Jackson.

ROCHESTER (N. Y.) ROENTGEN RAY SOCIETY

The Rochester Roentgen Ray Society at a recent meeting elected the following officers: President, A. L. Grohowski, M.D.; Vice-President, John W. Colgan, M.D.; Secretary-Treasurer, Theodore F. VanZandt, M.D., 501 W. Main St., Rochester 8. The Society meets on the last Monday of each month, September through May.

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY

The Pacific Northwest Radiological Society will hold its regular annual meeting in Seattle, Wash., May 8–10, 1959. Guest speakers are Dr. John Campbell, Professor of Radiology at the Indiana University Medical School, and Dr. Gilbert Fletcher, of the M. D. Anderson Hospital, Houston, Texas.

SOCIETY OF NUCLEAR MEDICINE

The sixth annual meeting of the Society of Nuclear Medicine will be held at the Palmer House, Chicago, Ill., June 18–20, 1959. Additional information may be obtained from Samuel N. Turiel, Administrator, The Society of Nuclear Medicine, 750 North Michigan Ave., Chicago 11, Ill.

COURSE IN CLINICAL USE OF RADIOACTIVE ISOTOPES

A course in the clinical use of radioactive isotopes will be given under the supervision of Dr. Sergei Feitelberg and Dr. Edith Quimby, of the Department of Radiology, Columbia University, New York City, from June 1 through June 27, 1959. This is a full-time course which includes lectures, experimental laboratory exercises, clinical rounds, and clinical measurements on patients and on specimens. In addition to Professors Feitelberg and Quimby, the teaching staff includes sixteen invited lecturers from the New York area, each presenting material in his own special field.

Lectures. Topics include physics of radioactive isotopes, interaction of radiation and matter, and technics of measurement of radiation and of radioactive isotopes. Clinical uses of radioactive iodine, phosphorus, and gold will be presented in detail; special lectures will cover miscellaneous diagnostic studies with radioactive iron, sodium, chromium, and other elements. Organization of isotope work in a hospital will be developed from a practical point of view.

Laboratory Work. Thirteen afternoons are devoted to experiments on basic methods of radioisotope measurements, technics used in clinical studies, and experience with actual clinical procedures.

Enrollment in the class is limited to 20; the fee is $300.

Inquiries should be addressed to Dr. Sergei Feitelberg, Mt. Sinai Hospital, Fifth Avenue at 100th Street, New York, N. Y.

COURSE IN SPECIAL RADIATION PROCEDURES IN CANCER QUEENS HOSPITAL CENTER, N. Y.

A one-week intensive course in the use of specialized radiation technics in the treatment of malignant disease will be given at the Queens Hospital Center, beginning Monday, Sept. 14, 1959. Details may be obtained from Dr. Philip J. Kahan, Supervising Medical Superintendent, Queens Hospital Center, 82-68 164th St., Jamaica 32, N. Y.

OREGON CANCER CONFERENCE

A Cancer Conference will be held in Portland, Oregon, July 16 and 17, 1959, under the joint sponsorship of the Oregon State Medical Society, the Oregon Division of the American Cancer Society, the University of Oregon Medical School, and the Oregon Academy of General Practice. It is planned for midsummer as a special feature of the Oregon Centennial celebration.

A copy of the complete program and hotel reservation forms may be obtained from Roscoe K. Miller, Executive Secretary, Oregon State Medical Society, 1115 S. W. Taylor St., Portland 5, Ore.

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

GYNECOLOGIC RADIOGRAPHY. By JEAN DALSACE, M.D., Chief of Sterility Service, Broca Hospital, University of Paris, Paris, and J. GARCIA-CALDÉRON, M.D., Radiologist, University of Paris School of Medicine, Paris. With a chapter on Radiography of the Breast by Charles-M. Gros, M.D., and Robert Sigrist, M.D. Foreword by I. C. Rubin, M.D. Translated by Hans Lehfeldt, M.D. A monograph of 188 pages, with 305 figures. Published by Paul B. Hoeber, Inc., Medical Book Department of Harper & Brothers, New York 16, N. Y., 1959. Price $8.00.

THE PNEUMOCONIOSIS PROBLEM WITH EMPHASIS ON THE ROLE OF THE RADIOLOGIST. By EUGENE P. PENDERGRASS, M.D., Professor of Radiology, University of Pennsylvania School of Medicine, Philadelphia, Pennsylvania. A volume of 146 pages, with 53 figures. Published by Charles C Thomas, Springfield, Ill., 1958. Price $6.75.

FRACTURE SURGERY: A TEXTBOOK OF COMMON FRACTURES. By HENRY MILCH, M.D., Emeritus Attending and Consulting Orthopedic Surgeon, Hospital for Joint Diseases, New York, and ROBERT AUSTIN MILCH, M.D., Assistant Resident Surgeon, Peter Bent Brigham Hospital, Boston. With a chapter on Anesthesia by Herbert D. Dubovsky, M.D., Director of Anesthesiology, Easton Hospital, Easton, Pennsylvania. A volume of 470 pages, with 671 illustrations on 480 figures. Published by Paul B. Hoeber, Inc., Medical Book Department of Harper & Brothers, New York 16, 1959. Price $17.50.

LIQUID SCINTILLATION COUNTING. PROCEEDINGS OF A CONFERENCE HELD AT NORTHWESTERN UNIVERSITY, AUGUST 20–22, 1957. Editors: CARLOS G. BELL, JR., C. E. Department, Northwestern University, and F. NEWTON HAYES, Health Division, Los Alamos Scientific Laboratory. Sponsored by the National Science Foundation and the Technological Institute of Northwestern University. A volume of 292 pages, with numerous figures and tables. Published by Pergamon Press, 122 East 55th St., New York 22, N. Y., 1958. Price $10.00.

HIGHLIGHTS OF PROGRESS IN RESEARCH ON CANCER. PART 1—1957. PART 2—January-March 1958. Items of Interest on Program Developments and Research Studies Conducted and Supported January 1957 through March 1958 by the National Cancer Institute. Prepared by the National Cancer Institute. Public Health Service Publication No. 623. A monograph of 52 pages. Published by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., 1958.

Book Reviews

THE LOVE OF A PHYSICIAN: GEORGE E. PFAHLER, M.D., PIONEER RADIOLOGIST. By MURIEL B. PFAHLER. A volume of 274 pages, with 4 figures. Published by Dorrance & Company, Philadelphia, Penna., 1958. Price $3.75.

The reviewer wishes he had the "tongue of a ready writer" to express the pleasure and satisfaction offered by Mrs. George E. Pfahler's beautifully written narrative of the fullness of her husband's life. His generous span of eighty-three years was lived with an astonishing intensity of purpose. The story really constitutes a history of the six decades of radiology that have passed since the momentous announcements of the discoveries of Roentgen, Becquerel, and the Curies. Those of us who knew George Edward Pfahler well will treasure this edifying record, penned in an attractive and understanding style that could come only from his devoted life partner. She has unselfishly stressed her husband's passion for his profession and for his country, diverting the emphasis from that private home life which, though naturally not for public discussion, must have constituted a wonderfully satisfactory relationship. The author merits commendation for the rare objectivity with which she has related this wonderful story of one man's accomplishments.

Dr. Pfahler's life covered a broad spectrum of interests in medicine, as well as in civic activities. To the highest degree he exemplified the clinical radiologist—a physician practicing radiology. He was a leader in the campaign against cancer and participated in an unusually large number of foreign and international radiologic gatherings.

This work is recommended especially to the younger radiologists, who will find it enjoyable and inspiring.

L'ANGIOGRAPHIE CÉRÉBRALE. By JOËL BONNAL, Neurochirurgien assistant de la Clinique Neurochirurgicale de la Faculté de Médecine de Marseille, and JACQUES LEGRÉ, Electroradiologiste des Hôpitaux de Marseille. Travail de la Clinique Neurochirurgicale de la Faculté de Médecine de Marseille et du Service Central de Radiologie de

l'Hôpital de la Timone. Preface by P[r] J. E. Paillas. A volume of 254 pages, with 223 figures. Published by Masson & Cie, 120, Boulevard Saint-Germain, Paris 6[e], 1958. Price 6,000 fr.

This French monograph is one of the most complete résumés of the field of cerebral angiography which has appeared in the French literature. The text is supplemented by a rather extensive bibliography, so that the reader who is interested in following up any particular phase of the subject may do so.

The first portion of the book considers the technic, complications, contraindications, and indications for cerebral angiography. The anatomical considerations relative to carotid and vertebral angiography, the benefit of using different positions, the importance of the anatomy of the deep veins, and the speed of circulation in the various systems are discussed. Even angiography of the orbit is allotted a little space.

The diagnostic possibilities in the cerebral angiogram are rather well explored. These include the diagnosis of brain tumors with their vascular patterns and displacements, special attention being given to the effects of hydrocephalus and internal herniation under the falx or the tentorium. The effects of tumors in various portions of the brain are discussed in detail. Aneurysms, vascular malformations, subdural hematomas, and obstructions of the internal carotid and middle cerebral vessels are discussed. Occasionally thromboses in the vertebral arteries or in the large venous sinuses are discovered. The authors maintain that thrombosis of the superior longitudinal sinus may be suspected in the absence of visualization of that sinus if the inferior longitudinal sinus and other venous sinuses are well demonstrated. It is doubtful if this is always a completely valid diagnostic sign.

In general, this book is well illustrated and gives a relatively good coverage of the field of cerebral angiography.

AMÉLIORATION ET REPRODUCTION DES RADIOGRAPHIES PAR MODULATION ÉLECTRONIQUE: LE LOGETRON. By A. JUTRAS, Professeur de radiologie, Université de Montréal, and H. FISCHGOLD, Neuro-Radiologiste de l'Hôpital de la Pitié, Paris. Radio-diagnostic et radio-anatomie de précision. A volume of 122 pages, with a Mémoire original by D. R. Craig, in English; 104 roentgenograms, 6 photographs, and 11 drawings (legends in French and English). Published by Masson & Cie, 120 Blvd. Saint-Germain, Paris 6[e], 1958. Price, paper-bound, 4,500 francs.

This monograph gives a rather extensive discussion of the LogEtron showing how it may be used to make reproductions of roentgenograms or photographs on film or on photographic paper. Special mechanisms such as "dodging" are described to improve the detail further.

In the appendix a reprint of the original paper by Craig is given in English. Following this, there are twenty-eight plates showing the value of enhancing the contrast by the LogEtron method.

LINFOPATÍAS TUMORALES: PATOLOGÍA, CLÍNICA Y TRATAMIENTO. By MANLIO FERRARI, Profesor titular de Patología Médica de la Facultad de Medicina de Montevideo; Internista del Instituto de Radiología y Ciencias Físicas, and HELMUT KASDORF, Profesor adjunto de Radiología de la Facultad de Medicina de Montevideo; Radioterapeuta del Instituto de Radiología y Ciencias Físicas. A monograph of 204 pages, with 70 figures. Published by Lopez & Etchegoyen, S. R. L., Junín 863, Buenos Aires, Argentina, 1957.

Although the authors of this monograph present no statistical analysis of their material, they mention that it included 267 cases of malignant lymphoma. After a brief introduction, in which the classifications of Shields Warren, and of Custer and Bernhardt are reproduced, there are chapters on "gigantic follicular lymphoblastoma" (with 8 personal observations), on lymphosarcoma (38.9 per cent of their 267 patients), a round 100 cases of Hodgkin's disease (called "malignant granulomatosis"), 10 cases of reticulosarcoma, and 12 instances of "anaplastic sarcoma of the lymphoid tissue." Lymph node biopsy is stressed as the proper diagnostic method, but in addition the authors seem favorably impressed with the puncture method of obtaining cytological specimens for examination, not only from lymph nodes, but especially from the "mediastinum," liver, and spleen. Some forty pages are devoted to therapy, emphasis being placed on palliative roentgen irradiation, without neglect of the chemotherapeutic compounds made available in recent years.

The need for a unified classification is mentioned, but there is no attempt to accomplish this, Kaposi's sarcoma, mycosis fungoides, and Spiegler-Fendt's "sarcoid," for example, being briefly discussed in the section on lymphosarcoma. The leukemias are not included, nor is there any statement as to the possibility of a relationship (except for Custer's classification). But if the authors avoid controversial items, they bring out practical details for which one may recommend this text both to the student and to the practitioner.

ERNIE E RELAXATIO DEL DIAFRAMMA. By G. BALDINI, L. FERRI, and L. RONCORONI. Preface by Prof. Arduino Ratti. A volume of 154 pages, with 52 roentgenograms and 2 diagrams. Published by Casa Editrice Renzo Cortina, Viale Golgi 14, Pavia, Italy, 1957. Price 2,500 lire.

This monograph opens with an introductory section which deals with semantic, embryogenetic, anatomic, clinical, and general roentgenologic

features of diaphragmatic hernia. The misnomer eventration, for example, is rejected in favor of the term relaxation, defined as a congenital or acquired atrophy of the diaphragm, with consequent diminution or loss of its contractibility. Brief chapters are devoted to the various types of hernia, the Bochdalek, congenital defects, hiatus hernia, congenitally short esophagus, sliding hernia and traumatic hernia. The longest chapter is the one on diaphragmatic relaxation. Some of the authors' statements are questionable, such as that quoted from Eberl, that the diagnosis of hiatus hernia is easy for the pathologist.

After a short enumeration of possible complications, there is a concluding chapter on the indications for surgical treatment. It carries the controversial generalization that "in the large majority of cases," the operative results are "brilliant," just because the barium meal study, performed shortly afterwards, reveals that all viscera are in their anatomical location.

The appended bibliography (revised to 1955) is not as profuse as one would have expected from the text, which abounds with quotations. The reproductions are satisfactory. Properly edited, this monograph could have been boiled down to the size of a substantial article. For the most part statistical analysis of personally observed cases is neglected. Could it be that the authors tried to compensate for this lack by indulging in scholastic pursuits?

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ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Skull Dehiscence and Dural Laceration in Unrecognized Familial Craniostenosis. Martin Peter Sayers and Clarence I. Britt. J. Dis. Child. **95:** 524–528, May 1958. (1275 Olentangy River Rd., Columbus 8, Ohio)

A three-month-old child sustained a fracture of the right parietal region near the midline, with separation of the fragments. The roentgenographic examination incidentally showed cranial stenosis with obliteration of the sagittal suture, dense calcification of the bone adjacent to the area of synostosis, and convolutional atrophy. A soft-tissue mass visible on the films over the fracture line was caused by extravasation of cerebrospinal fluid and fragments of brain under the galea.

Treatment consisted in removal of a strip of bone from anterior to posterior fontanelle, to include the fracture. The child was seen three months postoperatively because of a bulge at the operative site, at which time there was expansion of the cranial vault, with wide separation of the parietal bones. The rapid growth of the brain had caused a rupture of the periosteal graft inserted at the earlier operation, with herniation at the site of repair. The expansion of the brain after correction of the cranial stenosis supports the thesis that increase in skull size is largely secondary to pressure from normal brain growth.

Two roentgenograms. D. D. ROSENFELD, M.D.
Fontana, Calif.

Spontaneous Thrombosis of the Internal Carotid Artery in a Seven-Year-Old Child. Stanton L. Goldstein and John P. Burgess. J. Dis. Child. **95:** 538–540, May 1958. (823 Fifth Ave. Bldg., Moline, Ill.)

Spontaneous thrombosis of the internal carotid artery occurs primarily in middle age The authors report what they believe to be the second verified case in the first decade of life. A seven-year-old boy became suddenly ill, with headache, aphasia, and unconsciousness. There soon developed a partial right facial paralysis and incomplete weakness of the right upper and lower extremities. Two days following admission, left percutaneous cerebral angiography was performed. There was filling of the common carotid and external carotid arteries and of the first 3.5 cm. of the internal carotid, which beyond this point was completely obstructed. At autopsy, the left carotid artery was found to be thrombosed, the thrombosis extending into the anterior and middle cerebral arteries as well. There was no apparent collateral circulation from the ophthalmic artery or from the vessels on the opposite side through the circle of Willis. The intima of the internal carotid was not roughened or otherwise abnormal. No apparent cause for the thrombosis was found.

One roentgenogram. D. D. ROSENFELD, M.D.
Fontana, Calif.

THE CHEST

Pleuroesophageal Line in Normal Chest Roentgenograms. William L. DeGinder. J.A.M.A. **167:** 437–441, May 24, 1958. (2410 Rio Grand, Austin, Texas)

The pleuroesophageal line or esophageal-pleural stripe (see Cimmino: Radiology **67:** 754, 1956) has no pathological or prognostic significance but is seen in about one-fourth of all routine postero-anterior chest roentgenograms obtained in the 90 to 120-kvp range. It is usually 3 to 5 mm. wide and courses downward and to the left from the apex of the right lung to the arch of the aorta. Its many variations should be recognized to avoid attaching significance to this normal finding.

The author's explanation of the line is that it is formed by the esophageal wall, the visceral and the parietal pleura, and the connective tissue between, at the site where the right lung bulges behind the trachea against the air-containing esophagus. He uses excellent roentgenograms, with and without barium and/or barium-air in the esophagus, to demonstrate this line and its physiologic changes.

Twenty roentgenograms; 1 diagram.

B. JAY HILL, M.D.
University of Michigan

Pulmonary Embolism. Felix G. Fleischner. Canad. M. A. J. **78:** 653–660, May 1, 1958. (Beth Israel Hospital, Boston, Mass.)

Pulmonary embolism, with or without cardiovascular disease, is common after operations and injuries, during pregnancy, and in the puerperium. It may simulate any kind of cardiac, pulmonary, pleural, neurologic, or acute abdominal disease.

Early diagnosis is important in order to protect the patient against further embolic episodes. Chest pain and dyspnea, singly or combined, are the most common early signals; hemoptysis is comparatively rare. Probably the majority of embolisms occur without infarct formation, but if pulmonary infarction is diagnosed clinically or roentgenologically, embolism has occurred. Most infarcts are located in the lower portions of the lung; fewer are in the mid-lung field; only rarely do they occur in the upper lung field. Blood extravasation, without necrosis and eventual scar formation, is apparently more common than the classical infarct. Roentgenologists should look for either unilateral or bilateral signs of impaired ventilation, such as a high position of the diaphragm, diminished ventilatory diaphragmatic excursion, and basal atelectasis, often in the form of plate atelectasis. The diminished distance between the right dome of the diaphragm and the horizontal interlobar fissure is a "good yardstick for inhibited ventilation"

Pleural effusion may be the first objective clinical and roentgen manifestation of pulmonary embolism. It may hide an infarct which becomes visible with resorption or after thoracentesis with evacuation of fluid. Sometimes it is minute and not detectable roentgenologically.

The syndromes of acute and chronic cor pulmonale or pulmonary hypertension associated with pulmonary embolism are often revealed by (*a*) dilated hilar arteries forming a plump tumor-like shadow; (*b*) dilatation of the pulmonary artery trunk, most common in chronic embolism; (*c*) increased translucency due to oligemia of the lung field—lobar or unilateral in acute embolism; unilateral or bilateral in chronic embolism; (*d*) dilatation of the right ventricle in chronic cor pulmonale, best recognized by the increased area of contact between heart and anterior chest wall in the lateral roentgeno-

gram; (*e*) right inflow stasis as manifested by dilatation of the azygos vein and superior vena cava.

Ten case reports are presented, each illustrating one of the author's points.

Twelve roentgenograms; 2 diagrams; 1 table.

Histoplasmosis. A Review of One Hundred Consecutively Hospitalized Patients. Francis J. Curry and James A. Wier. Am. Rev. Tuberc. **77:** 749–763, May 1958. (F. J. C., 101 Grove St., San Francisco 2, Calif.)

The patients considered in this study were military personnel referred to Fitzsimons Army Hospital because chest lesions were demonstrated roentgenographically. The diagnosis was documented in 65 patients by isolation of the fungus and was presumptive in 35. In the latter group the diagnosis was based on (1) positive histoplasmin skin tests and diagnostically positive serologic tests and (2) histoplasmin positive skin tests and negative second strength PPD and coccidioidin tests. Ninety-four patients had been in one or more of the endemic areas and some of them had been born in such areas. Only 54 patients were symptomatic before hospitalization or at the time of admission. When present, symptoms were mild. Cough was the most common complaint. Chest pain, weight loss, fatigue, and malaise occurred occasionally, while blood streaking was found in 4 and spontaneous pneumothorax in 2 patients.

Roentgenographic patterns were divided into eight groups as follows:

1. "Coin" lesions. Fifty-five patients were found with discrete circumscribed densities varying from 1 to 3 cm. in diameter. Thirteen had associated hilar adenopathy.

2. Soft linear and nodular infiltration. This was found in 32 patients, of whom 24 had hilar adenopathy. The lesions were bilateral in 4 cases.

3. Hilar and mediastinal adenopathy. This abnormality was found in 37 patients, with an associated parenchymal lesion in 31.

4. Nodules—3 to 8 mm. in diameter. These nodules were sharply circumscribed and tended to be multiple and to occupy more than one lobe. Seven patients were found with nodules alone and in 8 a "coin" lesion was found in one lobe and nodular lesions were present in other lobes. The only difference between "coin" and nodular lesions was their size.

5. Cavitation. Four patients had an upper lobe infiltrate with gross cavitation. The disease in these patients resembled tuberculosis.

6. Pleurisy with effusion. This was found in 2 patients.

7. Pneumothorax. Spontaneous pneumothorax occurred in 2 patients. It was right-sided in both and both had nodular disease in the posterior segment of the right upper lobe.

8. Contracted right middle lobe. Five patients with a contracted right middle lobe had evidence of hilar adenopathy along with the middle-lobe disease, which resembled chronic non-specific middle lobe syndrome.

These roentgenographic lesions are not diagnostic. The cavitary disease often simulates tuberculosis. The adenopathy must be differentiated from sarcoidosis and malignant lymphoma, and the "coin" lesions are similar to those found in tuberculoma and solitary non-specific granuloma; if calcium is not present, they must be differentiated from malignant neoplasm. In this group of patients calcification was found only in the nodular densities and not in the more acute pneumonic forms of the disease.

Surgical treatment was carried out in many instances. Pneumonectomy was done in 1, a lobectomy in 5, segmental resection in 7, and a wedge resection in 58. Decortication was performed on the 2 patients with pleural effusion and hilar node excision was done on 11 patients with hilar adenopathy.

The clinical classifications of this disease are not entirely satisfactory, but it is generally considered to be either of a primary or re-infection type. The primary type consists of the acute progressively fatal generalized disease, somewhat similar in its widespread dissemination to miliary tuberculosis. A second form of acute disease also occurs. This type is symptomatic, is confined chiefly to the lungs, and may occur sporadically or in epidemics. The patients usually recover and the lesions regress completely or undergo calcification. The third primary form is the acute asymptomatic histoplasmosis which is most common and accounts for the calcified pulmonary nodules, hilar nodes, and splenic lesions often observed in asymptomatic persons with positive histoplasmin tests. The reinfection type of disease has been called by this term because it resembles a reinfection type of tuberculosis. It consists of the chronic progressive cavitary and nodular pulmonary disease. Occasionally generalized dissemination with fatal termination is noted in patients with this type of disease.

The significance of the serologic tests for histoplasmosis, as well as the skin reaction to histoplasmin, are discussed. The authors believe that the positive histoplasmin reaction should be interpreted in the same way as a positive tuberculin test and that it is indicative of a previous infection with the fungus, *Histoplasma capsulatum*. The significance of complement fixation is also discussed; a titer of one to sixteen, or greater, is considered diagnostic of "serologically proved" histoplasmosis.

Three roentgenograms; 8 tables.

JOHN H. JUHL, M.D.
University of Wisconsin

Thoracic Actinomycosis. Ewart M. Jepson, F. Clifford Rose, and Richard D. Tonkin. Brit. M. J. 1: 1025–1027, May 3, 1958. (Westminster Hospital, London, England)

Actinomycosis is a serious and chronic infection, often fatal if unrecognized until too late but responsive to proper treatment. Typically it does not respect fascial boundaries or endothelial surfaces which limit the spread of many other infections. The human infections are **not** caused by *Actinomyces bovis*, which produces "lumpy jaw" in cattle, nor is the incidence limited to country dwellers. *A. israeli* has long been considered the sole causative organism in man, but there is some evidence that the disease is a multiple infection, arising from a synergism between that organism and others, especially *Bacillus actinomycetem comitans*.

The authors report 2 cases of thoracic actinomycosis. The first presented as a pleural effusion, thought to be due to tuberculosis because of failure to respond to sulfadimidine and penicillin. Within three months the patient improved enough to be discharged and was not seen again until seven years later. At that time he again (or still) had a pleural effusion and, in addition,

osteitis of the ribs, manifested chiefly by subperiosteal calcification which the authors believe to be characteristic of actinomycosis [unfortunately poorly illustrated]. *A. israeli* was isolated, an empyema was drained, and massive penicillin therapy was started, but the patient died in adrenal failure from amyloidosis.

The second patient was more fortunate, having an early diagnosis. The presenting feature was an abscess over the upper dorsal spine, the result of vertebral involvement by a primary pulmonary or mediastinal infection. Treatment with penicillin and streptomycin for seven weeks met with excellent clinical response but four weeks later lesions were seen in both lungs, although the patient was asymptomatic. These responded to further therapy.

Five roentgenograms. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Distortion of the Bronchial Tree in Silicosis. H. Bohlig. Fortschr. a. d. Geb. d. Röntgenstrahlen **88:** 526–533, May 1958. (In German) (Städtische Krankenhauses Lüdenscheid/Westfalen, Germany)

According to the former international classification of silicosis, distortion of the bronchial system was considered to represent the highest degree of the disease. Distortion can, however, occur in all stages of silicosis and, if present, is typical although not pathognomonic.

Perivascular and peribronchial interstitial fibrosis may set in before nodular or miliary fibrosis of the parenchyma occurs. This depends on the loss of transport-function of the lymphatics, resulting in stagnation of the dust-lymph emulsion. The radiographic signs are distortion with changes in diameter of the bronchi and modification of the approximately 90° angle between the right upper lobe and right lower lobe bronchi and the approximately 80° angle on the left. The sharp lip at the bronchial ostium seen bronchoscopically may be rounded, resulting in blunting of the angles at the bifurcations of the main bronchi. This may also occur with neoplastic or chronic inflammatory infiltration and edema of the hila.

Radiographic demonstration is accomplished by tomography and bronchography (with Propyliodon-Cilag). The findings often explain discrepancies between severe functional respiratory disturbances and relatively minor changes seen on the routine chest film.

Seventeen roentgenograms.

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Silicosis of Ocher Workers: A Clinical and Anatomopathologic Study. A. D. Roche, D. Picard, and A. Vernhes. Am. Rev. Tuberc. **77:** 839–847, May 1958. (Public Services, Department of Vaucluse, France)

Ocher is mined in the south of France and is used for its coloring properties in the manufacture of varnish, lacquer, linoleum, etc. It is composed chiefly of silica but also contains a large proportion of iron and may produce a siderosilicosis. The roentgen findings are somewhat different from those observed in coal miners and in the usual type of silicosis. Most frequent is the pseudotumoral form, in which large rounded or oval masses are present in the upper lobes, tending to be bilaterally symmetrical. They are relatively clearly defined and are surrounded by a layer of parenchyma even on the mediastinal aspects. These lesions are associated with a considerable amount of emphysema, most marked in the lung bases. Nodular forms are also found, and small and large nodules may be present in the same patient. There is often some tendency toward confluence of the lesions. The granular appearance or "snow-storm" picture found in silicosis is not common.

Bilateral hilar adenopathy is nearly always present in these patients and many of the nodes are outlined by peripheral calcification, forming the egg-shell nodes which are described in silicosis. Pathologically, some of the dense pseudotumoral forms which are roentgenographically homogeneous may show central softening and necrosis with liquefaction in some instances. Examination of this liquid and of the tissues in one of the 14 cases reported revealed no evidence of tuberculosis.

Two roentgenograms. JOHN H. JUHL, M.D.
University of Wisconsin

Thesaurosis Following Inhalation of Hair Spray. A Clinical and Experimental Study. Martin Bergmann, I. Jerome Flance, and Herman T. Blumenthal. New England J. Med. **258:** 471–476, March 6, 1958. (Jewish Hospital, St. Louis, Mo.)

The cases of two young women are presented, in each of whom a previous radiographic examination of the chest was negative. Both patients were free of respiratory signs or symptoms and in both the discovery of what at first seemed to be a serious and widespread infiltrative process of the lungs caused considerable concern. The radiographic appearance of the chests suggested the possibility of inhalation of a noxious agent. The roentgenograms showed bilateral hilar adenopathy and diffuse reticular bilateral infiltration of the lung fields. Microscopic examination of a lymph node in Case I revealed evidence of some form of foreign-body granuloma. On questioning, it was found that both patients had been using various hair sprays as often as twice daily. After discontinuance of the use of the sprays, the chests returned to a normal appearance in about five months. Experiments were carried out in which a preparation of a well known brand of hair spray prepared in sterile physiologic saline was injected into the inguinal region in 3 guinea pigs. Examination of the area of injection when the animals were killed from thirty-five to seventy-five days after injection, showed granulomatous lesions similar to that found in the biopsy of the nodes in Case I.

Two roentgenograms; 6 photomicrographs.

ALFRED O. MILLER, M.D.
Louisville, Ky.

Staphylococcal Pneumonia. A Review of 21 Cases in Adults. A. M. Fisher, R. W. Trever, J. A. Curtin, G. Schultze, and D. F. Miller. New England J. Med. **258:** 919–928, May 8, 1958. (Johns Hopkins University School of Medicine, Baltimore, Md.)

Twenty-one cases of staphylococcal pneumonia in adults are analyzed. Fourteen of the patients died, and 7 recovered. Though certain features in staphylococcal pneumonia indicate a probable relation to influenza, none of the patients in this series were thought to have that disease. Eleven, however, had serious debilitating conditions, and a higher mortality was observed in such cases. In 2 patients the pneumonia resulted in death in three days. The lungs were involved bilaterally in 12 cases and unilaterally in 9 cases. Cyst or abscess formation was demonstrated in 15 patients, as solitary lesions in 5 and as multiple lesions in 10. Pleural changes were found in 8 cases, progressing to empyema in 4.

The danger of secondary bacterial infections in epidemics of influenza is obvious. Infections due to drug-resistant staphylococci represent the most serious hazard.

Five cases considered of unusual interest are reported at some length.

Eight roentgenograms; 1 table.

THOMAS R. MARSHALL, M.D.
Indiana University Medical Center

Pulmonary Metastasis from Occult Primary Sites Resembling Bronchogenic Carcinoma. Benjamin E. Greenberg and Joseph M. Young. Dis. of Chest **33:** 496–505, May 1958. (VA Hospital, Kennedy Division, Memphis, Tenn.)

Six cases of metastatic lung tumors from occult primary sites are presented. The clinical, radiologic, and pathologic features of these cases were indistinguishable from bronchogenic carcinoma. A positive tissue diagnosis of carcinoma was obtained in all patients, either by node biopsy or direct biopsy at thoracotomy. All patients were considered to have primary bronchogenic carcinoma and were treated accordingly.

In 5 patients the primary tumor was found at autopsy and in 1 the appearance of multiple lung nodules following therapy led to intravenous urography, which was indicative of carcinoma of the kidney, subsequently confirmed at autopsy. In 3 cases the site of the primary tumor was the pancreas, and in 2 the prostate.

The authors feel that metastasis directly through lymphatics to the hilar and mediastinal nodes, or metastasis to the wall of the bronchus through the bronchial or pulmonary arteries, is responsible for the production of a pathologic state indistinguishable from primary bronchogenic carcinoma.

Ten roentgenograms; 1 photomicrograph.

RICHARD H. GREENSPAN, M.D.
University of Minnesota

Pulmonary Edema Occurring During the Course of Renal Azotemia: Its Differential Radiologic Diagnosis. Rose Lee Nemir and Samuel L. Beranbaum. J. Dis. Child. **95:** 516–523, May 1958. (New York University-Bellevue Medical Center, New York 3, N. Y.)

A case of renal azotemia associated with pulmonary edema occurring in a ten-year-old boy is reported. Heart failure developed during hospitalization and roentgenograms confirmed the presence of an enlarged heart, as well as bilateral hilar densities consistent with pulmonary edema. Within forty-eight hours after digitalization, the roentgenogram showed marked improvement in the extent of the edema, although the heart size was unchanged, and the elevated blood urea nitrogen showed no improvement.

The authors feel that the term "uremic pneumonia" is a misnomer and that the presence of edema in the lungs depends on three factors: heart failure, azotemia, and extensive vascular damage. The lack of vascular pathology in children would account for the rarity of this phenomenon, even though azotemia is frequent. In the reported case, autopsy showed evidence of atherosclerosis of the aorta. Another explanation for the infrequency of this condition is that, since it is acute and transient and sometimes asymptomatic, it may pass unnoticed unless roentgenograms are more frequently utilized. Differential diagnosis includes bilateral pneumonic changes associated with infantile cystic pancreatic fibrosis and acute miliary tuberculosis. In these conditions, there usually is adenopathy and the heart is not enlarged.

Four roentgenograms: 1 diagram.

D. D. ROSENFELD, M.D.
Fontana, Calif.

Roentgen Studies of Ventilatory Dysfunction: An Analysis of Diaphragmatic Movement in Obstructive Emphysema. Sumner Goldenthal, Bruce W. Armstrong, and Robert M. Lowman. Am. J. Roentgenol. **79:** 279–292, February 1958. (Yale Medical Center, New Haven 4, Conn.)

Gross ventilatory dysfunction is best observed by noting the speed and amount of pulmonary emptying during a forced rapid expiration from the position of full inspiration. Stress is placed on the forced aspect of the expiration as well as its rapidity, since the abnormality is only rarely observed during quiet respiration. Simple spirometry and pneumotachography will record the exchange adequately but will not differentiate between right and left lungs. The more complicated differential bronchospirometry requires expensive laboratory equipment and the services of a pulmonary physiologist, anesthetist, and laboratory technician(s). Fluoroscopy is readily available in most hospitals and gives instantaneous readings of ventilatory function by a study of diaphragmatic motion. Its chief shortcoming is the subjective nature of the observed results.

Kymography, used for years to study respiratory disorders, has been modified by the authors to record the quantitative relationship between differential pulmonary ventilation in patients with obstructive emphysema and the degree and speed of diaphragmatic elevation during forced rapid expiration. A conventional roentgen kymograph is used containing a special grid with lead strips 30 mm. wide, 1.0 mm. apart. This allows the recording of diaphragmatic motion over a strip of film measuring 30 mm. wide. The exposure factors were 72 inches target-film distance; $^1/_{16}$ in. Al filter; h.v.l. 2.60 mm. Al; 85 kv; 100 ma; 4 seconds exposure time. The film moves at right angles, from left to right, to the fixed grid strips. The record of motion of three 1-mm. segments of each leaf of the diaphragm can usually be obtained on one 14 × 17-inch film. A motor-driven timer mounted on the kymograph records every fifth of a second on the film.

The patient is coached on the performance of a maximum forced expiration from a position of maximum inspiration. Each record usually contains at least 3 single wave crests for each hemidiaphragm. The expiratory curve normally rises suddenly and is accompanied by rib descent well demonstrated on the film.

In the 20 normal subjects measured, the right diaphragm rose an average of 6.6 cm. and the left 7.7 cm., with 18 of these patients having measurements within 4 mm. of the average. The speed of expiration, or rise of the diaphragm, was relatively rapid in this group, being 89 per cent complete within the first second. Between the first and second seconds the rise is slower with a gentle contour to the curve. At about the beginning of the third second a plateau is reached which represents the level of the diaphragms at maximum expiration. If gas is present in the gastric fundus there will be a double curve on the tracings of the left hemidiaphragm but this does not impair the measurements. In fact, the two waves are so similar in amplitude that, where the diaphragm is obliterated by pleural thickening, the inferior curve of the stomach bubble may be

used in the measurements. Cardiac contractions may give the left diaphragm curve a notched appearance, but this too need not interfere with either qualitative or quantitative conclusions.

This simple, rapid, atraumatic method of detecting ventilatory dysfunction serves as an indicator of the amount of remaining lung parenchyma active in respiration. The authors had used the procedure in 47 cases of ventilatory dysfunction. Six of these are reported. Certain deviations from the method as described are required in special cases. To illustrate this, a case of diaphragmatic paralysis associated with obstructive emphysema is presented.

Fourteen roentgenograms; 15 line drawings.

SAUL SCHEFF, M.D.
Boston, Mass.

Mediastinal Emphysema: A Complication of Bronchoscopy. Robert N. Armen, C. S. Morrow, and Stephen Sewell. Ann. Int. Med. **48:** 1083–1096, May 1958. (VA Hospital, Brooklyn 9, N.Y.)

Few articles have dealt with the occurrence of mediastinal emphysema as a complication of bronchoscopic procedures. The authors report a case and suggest the possibility that a mechanism other than traumatic perforation of a main airway may be responsible for mediastinal, pulmonary interstitial, and subcutaneous emphysema incident to bronchoscopy.

The patient was a 60-year-old white male on whom a diagnostic bronchoscopy was performed because of a possible mass in the left hilar region. The findings were reported as normal except for a small elevation of the mucosa at the junction of the left main bronchus and the left upper lobe bronchus, without evidence of malignancy. Three hours after the bronchoscopy, marked subcutaneous emphysema involving the neck, face, chest, and arms was noted. The patient did not manifest any respiratory distress, and examination of the heart revealed no unusual findings. Three and a half hours later the subcutaneous emphysema had extended to the forearms and the eyelids and was more pronounced over the chest. A film obtained at this time disclosed mediastinal emphysema, subcutaneous emphysema of the anterior and posterior chest walls, and possible pulmonary interstitial emphysema. The patient became cyanotic and dyspneic, with severe substernal pain, tachycardia, and a moderate fall in blood pressure. An emergency operation was performed about twelve hours after bronchoscopy: an incision was made in the subcutaneous tissue of the neck just above the sternum and the clavicles, and an artery forceps was inserted into the mediastinum and spread open. As a result of these maneuvers, air escaped from both the subcutaneous tissue and the mediastinum. The patient experienced marked relief from his respiratory difficulty and substernal pain.

Twenty minutes after the operation, a chest film again disclosed subcutaneous emphysema of the neck and the lateral chest walls. Air, however, was present only on the right side of the mediastinum, the air streaks having disappeared from the pulmonary fields. Early the following day roentgenograms of the chest on inspiration disclosed the presence of air not only on the right side, but also on the left side of the mediastinum. The expiratory film failed to show any air in the mediastinum but disclosed the probable presence of air in the pulmonary interstitial tissue and/or the subcutaneous tissue of the chest wall on the left, manifested by air streaks radiating from the hilus. Under appropriate treatment the dyspnea was relieved, and about ten days later the subcutaneous emphysema had vanished.

Since substernal pain is a prominent symptom of mediastinal emphysema, other conditions characterized by pain at the same site must be considered in the differential diagnosis, as myocardial infarction, dissecting aneurysm of the aorta, acute pericarditis, and spontaneous pneumothorax. Rupture of the esophagus, which might cause both mediastinal emphysema and mediastinitis, must also be considered. The presence of air in the subcutaneous tissue of the neck and the postero-anterior erect chest film is a characteristic feature if an air leak from local structures in the neck can be excluded. The postero-anterior chest film usually discloses lateral displacement of the mediastinal pleura of each side and radiolucency of air within the mediastinum. The lateral chest film is not diagnostic unless pneumothorax is eliminated as a possibility.

The causes of mediastinal emphysema appear to be legion. In the case described, the authors believe one of the following three mechanisms to have been responsible: (1) direct perforation of the trachea or the main bronchus by the bronchoscope; (2) perforation of the left main bronchus by the biopsy forceps; (3) the rupture of emphysematous alveoli incidental to the increased expiratory pressure produced by the presence of the bronchoscope in a patient who already had exhibited obstructive ventilatory signs prior to bronchoscopy. The first of these, the authors believe, can be ruled out; the second is more probable, but the third remains a possibility.

On the basis of whether or not cardiorespiratory embarrassment exists, mediastinal emphysema is classified as malignant or benign. In the benign form, the pressure disturbance in the mediastinum resulting from the intrusion of air is minimal. In the malignant form, cardiorespiratory embarrassment occurs chiefly because of the increased mediastinal pressure and the extensive infiltration of the air through the pulmonary interstitial tissues. A complicating pneumothorax, if present, adds to the distress. As a result, there are displacement and limited motion of the lungs, restriction of the blood flow through the vena cava and the pulmonary veins, and hypoxia, with resultant pulmonary arterial constriction and hypertension.

The therapy of mediastinal emphysema depends upon whether it is malignant or benign. The benign form requires no specific treatment. In the malignant form surgical intervention is urgently indicated, followed by administration of oxygen, sedatives, antibiotics, bronchodilators, and steroid and ACTH therapy.

Six roentgenograms. STEPHEN N. TAGER, M.D.
Evansville, Ind.

THE HEART AND BLOOD VESSELS

Cardiac Valve Calcifications and Registration of Their Movements. Osborne Bartley. Acta radiol. **49:** 329–347, May 1958. (Roentgen Department III, Sahlgrenska Sjukhuset, Gothenburg, Sweden)

The author discusses the nature of cardiac valve calcifications, their relation to valvular heart disease, and their incidence in autopsy material. He was unable to find in the literature any significant figures indicating the frequency of their roentgen demonstration, though this may sometimes be a decisive factor in the diagnosis of aortic or mitral valvular disease.

Calcifications have been demonstrated by fluoroscopy, conventional roentgenography, and tomography, the most reliable of these procedures being fluoroscopy. The author himself used electrokymography and cinematography for registration of valve calcifications in relation to the cardiac cycle. When the calcifications were large, the valve movements could be demonstrated by electrokymography, but cinematography proved more satisfactory and recorded the movements of even small calcifications. The movements of the aortic and mitral valve calcifications were found to differ in direction, speed, and amplitude, as well as in relationship to the cardiac cycle. These observations permit localization of the involved ostium.

Endocarditic calcifications are always indicative of valvular heart disease. Large areas of calcification in the mitral valve and extensive calcification of the aortic valves associated with mitral stenosis often betoken a poor surgical result. According to some authors generalized atherosclerosis occurs more frequently in subjects with atherosclerotic calcifications, hence, the demonstration of these may have prognostic significance. Calcifications resembling a string of pearls in both aortic and mitral valves, as well as large mitral valve calcifications, are typical of endocarditis.

Six cases, in which 7 valve calcifications were demonstrated, are reported.

Ten figures, including 4 roentgenograms.

H. C. JONES, M.D.
Grand Rapids, Mich.

Clinical Importance of the Roentgen Demonstration of Mural Calcifications in the Area of the Left Auricle. R. Jürgens, A. Stecken, and H. Witte. Fortschr. a. d. Geb. d. Röntgenstrahlen **88:** 534–545, May 1958. (In German) (I. Medizinische Universitätsklinik und Poliklinik der Charité, Berlin, Germany)

Atrial mural calcification was found in 4 among 180 cases of mitral lesions in rheumatic heart disease. Two types of calcification are differentiated: (1) an irregularly shaped eggshell type in the subendothelial layer of the atrial wall; (2) laminated, roundish calcified thrombi intimately adherent to the wall. Transitional forms also occur.

Rheumatic endocarditis with or without mural thrombosis is alone responsible for the calcifications. They occur in 1 to 2 per cent of cases of mitral stenosis, mostly with mitral insufficiency and aortic and/or tricuspid valvulitis, and, clinically, atrial fibrillation. Metastatic calcinosis, hyperparathyroidism, and D-hypervitaminosis did not result in atrial calcifications.

Simultaneous frontal and sagittal tomography is the method of choice for demonstration of mural calcifications, since it shows all portions of the left atrium. Fluoroscopy, kymography, and an over-penetrated Bucky technic are less satisfactory, but may be used to supplement the tomographic study.

The presence of atrial wall calcification is in general a contraindication to mitral valvulotomy and may necessitate an approach *via* the pulmonary veins.

Twelve roentgenograms: 1 table.

G. A. DOEHNER, M.D.
St. Vincent's Hospital, New York

Traumatic Armour Heart. Joseph Maciejewski. Am. Heart J. **55:** 729–733, May 1958. (Poznan, Poland)

Two cases of traumatic armour heart have been published previously (Warburg: Am. Heart J. **49:** 633, 1955). A third is presented by the author.

Routine microfilms of a 59-year-old male showed an irregular silhouette of the heart, and as a result further studies were made. Twenty years previously the patient had experienced a crushing injury to the chest, followed by dyspnea, hemoptysis, severe chest pain, and edema in the lower extremities. After six months he was able to return to work.

The heart was found to be enlarged. In the left anterior oblique position it appeared to be surrounded by a thick band of calcification which extended up to the great vessels. Apparently this was due to previous hemopericardium and hemothorax followed by adhesions and pericardial calcification. The patient was almost asymptomatic at the time of examination.

Three figures, including 2 roentgenograms.

ROGER M. STOLL, M.D.
New York, N. Y.

Massive Dilatation of the Left Atrium: A Case Report. Morris A. Shapiro and Gerald W. Parker. Ann. Int. Med. **48:** 1097–1106, May 1958. (1603 Union St., Schenectady 8, N. Y.)

Massive atrial dilatation is considered a rare entity. Fewer than 40 cases are on record. The course of the disease in the case reported here was followed by roentgen studies and physical examinations over an interval of twelve years.

A 24-year-old white male was first seen on Sept. 30, 1943, because of shortness of breath, swelling of the ankles, and expectoration of blood. At the age of thirteen he had had scarlet fever and at eighteen had been told that he had a murmur. A chest film showed a marked enlargement of the heart, with special fullness of the outflow tract of the right ventricle and a greatly enlarged left auricle. The hili were considerably increased in density, suggesting pulmonary congestion. An electrocardiogram revealed auricular fibrillation. The patient was considered to have rheumatic heart disease (inactive), mitral stenosis, atrial fibrillation, congestive failure, and right lower lobe pneumonia. He was discharged, improved, after seventeen days.

On readmission in 1944 and again in 1948, the enlargement of the left auricle appeared about the same as on the original examination. On the fourth admission, in January 1955, the heart showed progressive enlargement and what appeared to be a large cystic mass was demonstrable, blending with the cardiac shadow and displacing it anteriorly and to the left. The esophagus was displaced to the right and posteriorly. At necropsy, in October 1955, this cystic structure was shown to be the enlarged left atrium, which measured 20 × 15 × 10 cm. and contained an estimated 1,500 to 2,000 c.c. of blood. Sections of the dilated left atrial wall revealed focal thickening of the endocardium, with fibrous tissue replacement of the wall in some areas. Marked interstitial fibrosis of the myocardium was noted.

Extreme dilatation of the atrium to the right has almost always been associated with mitral stenosis. Fibrotic changes in the myocardium are characteristic, and the etiology of the massive enlargement is inherently associated with thinning of the atrial wall as a result of increased intra-auricular pressure from stenosis and often an accompanying regurgitation. Because the anatomic position of the left atrium is such that the left main stem bronchus is intimately in association superiorly, the esophagus and vertebral column pos-

teriorly, and the left ventricle on the left, massive enlargement can take place only to the right.

In the earlier stages, no characteristic physical signs are present, and only roentgenologic study makes the diagnosis possible. The x-ray examination should be made in the oblique positions, preferably the right anterior oblique, and should always include fluoroscopy and a barium swallow. When the enlargement is such that the right thoracic wall is reached by the enlarging atrium, certain signs are suggestive. Dullness may be present to the right of the sternum and in the right axilla and a forcible systolic thrill may be palpable to the right of the sternum. Atrial fibrillation is almost invariably present.

Radiologically, in the frontal view the projecting left atrium in early stages reveals itself as a convex curve or double curve at the upper margins of the right atrium, thus forming part of the right border of the heart. In extreme cases the esophagus, when filled with barium, appears narrowed, constricted, and displaced posteriorly and to the right, and the postcardiac space is obliterated. The angle of bifurcation of the bronchi is directly related to the left atrial enlargement, which is strongly suggested by a tendency toward an obtuse angle.

Massive dilatation of the left atrium represents an exaggeration of the enlargement seen in mitral stenosis.

Five roentgenograms; 1 photograph.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

Roentgen Diagnosis of Pericardial Effusion: New Angiocardiographic Observations. Israel Steinberg, Herbert V. von Gal, and Nathaniel Finby. Am. J. Roentgenol. **79:** 321–332, February 1958. (525 East 68th St., New York 21, N. Y.)

In routine studies the most reliable early sign of a pericardial effusion is enlargement of the cardiac shadow on successive roentgenograms. The normal 15 to 30 c.c. of fluid in the sac must, however, increase to at least 250 c.c. to be detected clinically or radiographically. The increasing fluid first collects in the most dependent portion of the pericardium, then retrosternally. The length of the heart increases faster than the width. Straightening of the normal contour, particularly the left, is further evidence of effusion. If the accumulation is large, the right cardiohepatic angle becomes acute. At fluoroscopy the configuration of an effusion remains unaltered during the respiratory maneuvers of Müller or Valsalva while dilated hearts change in shape.

The authors utilized angiocardiography in a selected series of 30 cases in which pericardial fluid was not clearly recognized by routine measures and represented a problem in diagnosis. Opacification of the heart chambers not only permits an estimation of their size but allows an evaluation of the wall thickness as well. On the right side the normal atrial wall ranges from 1 to 3 mm.; the ventricular chamber from 3 to 5 mm. The left ventricular wall is about 10 mm. thick and, when hypertrophied, rarely exceeds 20 mm.

In the 30 patients studied the distance between the contrast medium within the chamber and the air-containing lungs was great enough in the frontal view to distinguish effusion from a large, dilated heart. In addition, lateral views always showed the pericardial fluid to be anterior (retrosternally) and infracardiac, resulting in backward displacement of the heart shadow. Small collections first accumulate below the under surface of the heart. As fluid increases, it spreads anteriorly to encroach on the substernal space; it then appears along the lateral borders of the heart to straighten the cardiac silhouette. In massive effusions the lateral recesses of the sac present the appearance of "water wings." When these fill asymmetrically, a pericardial or mediastinal mass may be suspected.

Twenty-seven roentgenograms.

SAUL SCHEFF, M.D.
Boston, Mass.

A New Needle and Safer Method of Arteriography. Elias A. Husni. Surg., Gynec. & Obst. **106:** 627–630, May 1958. (Western Reserve University, Cleveland, Ohio)

The author describes an aortogram needle which is said to minimize the danger of extravasation or intramural injection of the contrast medium. The needle is of 16 or 18 gauge and is 17 cm. long. It has a closed beveled tip and empties *via* an opening on the side opposite the bevel, 2 to 3 mm. from the tip. The opening contains a projecting sector which causes the ejected material to spray with considerably less pressure than the jet-like ejection from a standard needle. The closed tip is said to diminish the chances of punching out a segment of a sclerotic artery, thus minimizing the danger of bleeding or embolism.

Arteriography is done percutaneously under 1 per cent procaine local anesthesia. The patients are tested with an intradermal injection of iodopyracet on the day previous to the examination. If the result is negative, they are further tested by an intravenous injection of 1.0 c.c. of the same material. At the time of the examination 2 to 3 ml. of the contrast medium is injected and a preliminary film is taken to determine that the injection is being made in the desired site, and that no extravasation or intramural injection is taking place. This also acts as an additional sensitivity test.

For femoral arteriography 15 to 25 ml. of 35 per cent iodopyracet is used; for abdominal aortography 20 to 25 ml. of 70 per cent Diodrast. One milliliter of 2 per cent procaine solution is added before injection, and is believed to minimize sensitivity reactions.

To protect personnel about 130 cm. of plastic tubing is substituted for the short tubing that connects the syringe containing the contrast material to the needle. This permits the examiner to stand in the protection of a lead screen.

The new needle has been in use at the City Hospital of Cleveland for more than one year without complications attributed to its use. The number of examinations is not stated.

Three roentgenograms; 3 diagrams.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Retrograde Aortography under Hypothermia in Infancy and Early Childhood. Howard A. Joos and John L. Johnson. Am. Heart J. **55:** 743–753, May 1958. (University of Southern California School of Medicine, Los Angeles, Calif.)

The purpose of this paper is to describe a method for retrograde aortography under hypothermia which improves the quality of the films and enhances the safety of the method in infants and children. Twenty-seven patients have undergone this procedure. Few of this group were cyanotic. There was, however, a high inci-

dence of cardiac enlargement, congestive heart failure, and growth retardation, reflecting serious circulatory stresses justifying early investigation.

Ice baths or plastic bags filled with ice were used to induce hypothermia, being discontinued after an average of half an hour, when the temperature had fallen to about 34°. The aortograms were made at an average of sixty-eight minutes after application of the ice.

Hypaque 50 per cent was used as the contrast medium in doses of 0.75 c.c. per kg. for older patients and 1.0 c.c. per kg. for infants. Rapid intra-arterial retrograde injection is made, with compression of the carotids. The film changer is activated just prior to the injection and continued to one second after the injection. Twelve exposures per second are taken. The site of injection is the right or left brachial artery.

From their series the authors conclude that this method surpasses selective angiocardiography in defining the anatomy of aortic coarctation. It also establishes clearly patency of a ductus arteriosus and is of value in differentiating a patent ductus and aorticopulmonary fenestration from intracardiac causes of large left-to-right shunts.

Hypothermia slows the circulation and thus minimizes dilution of contrast medium and lengthens the time of opacification of important structures. Visualization is therefore better. There are few untoward effects, suggesting that hypothermia may enhance the safety of this procedure.

Nine roentgenograms; 13 tables.

ROGER M. STOLL, M.D.
New York, N.Y.

Aortic Thrombosis. F. Starer and D. Sutton. Brit. M. J. **1**: 1255–1263, May 31, 1958. (St. Mary's Hospital, London, W. 2, England)

The experiences of the authors in 32 cases of aortic thrombosis are analyzed. Although aortic thrombosis must first be suspected clinically, aortography is a must in the work-up, since only this procedure can show the extent of the block and the state of the collateral circulation. Plain films are of no help because the amount and location of calcification of vessel walls bear no relation to thrombosis. The extent of the thrombus varied somewhat, but the typical case involved both common iliacs and the distal aorta up to the renal arteries. In 5 cases the thrombus appeared to be extending into one or the other of these latter vessels. Gangrene was surprisingly uncommon and it now appears that many patients can lead useful and moderately active lives for many years. It is too soon to evaluate the results of the various surgical procedures which are being used for this condition.

It is of interest that in three of the authors' cases there was some relation to trauma.

Nine roentgenograms; 2 diagrams; 2 tables.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Isolated Congenital Absence of the Right Pulmonary Artery: A Caution as to its Diagnosis and a Proposal for its Embryogenesis. Report of a Case with Review. Lawrence J. Schneiderman. Am. Heart J. **55**: 772–780, May 1958. (Boston City Hospital, Boston, Mass.)

A case is presented of isolated absence of the right pulmonary artery in a six-week-old Negro male admitted because of irritability and wheezing for one week. Eleven previously reported cases of this anomaly are briefly reviewed. The chest film in the author's case showed findings resembling those in the cases from the literature. In spite of digitalization the infant suddenly expired on the third hospital day. At autopsy the heart showed right ventricular hypertrophy. The pulmonary artery led to the left lung and had no branch to the right lung. An anomalous artery arose from the ascending aorta and entered the hilus of the right lung.

In the absence of the right pulmonary artery the heart may or may not appear enlarged on the routine chest film. Four signs are of significance: (1) increased radiolucency of the affected lung, with diminished vascular markings, (2) decreased size of the affected hemithorax, (3) mediastinal shift to the affected side, (4) absence of the "hilar comma" shadow.

The diagnosis is best made by angiocardiography, which shows non-filling of the pulmonary artery. The author feels that this condition has been overdiagnosed in recent years. A similar defect may also be seen due to atresia, severe stenosis, and thrombo-embolic obstruction.

With absence of the pulmonary artery, however, there is also an anomalous artery from the aorta which goes to the affected lung, and this should always be looked for on the angiocardiogram.

This condition becomes important when surgery of the non-affected lung is contemplated. It is suggested that it might be possible to anastomose the proximal end of the anomalous systemic artery to the pulmonary trunk and then supply the remaining lung with unoxygenated blood from the right side of the heart.

The author discusses the possible embryogenic cause for this condition which involves a defect in the development of the sixth aortic arch. He suggests that there is retardation of the migration of the right sixth aortic arch during the division of the truncus arteriosus. When the truncus splits, the right sixth aortic arch is therefore caught on the wrong side. Thus the anomalous artery arising from the aorta represents what would have been the right pulmonary artery. This explanation is partially substantiated by the fact that absence of the right pulmonary artery most often occurs alone. Absence of the left pulmonary artery usually occurs with other cardiac defects and is not to be explained on the same basis.

One roentgenogram; 2 photographs; 1 diagram; 1 table.

ROGER M. STOLL, M.D.
New York, N. Y.

THE DIGESTIVE SYSTEM

Peptic Esophagitis and Peptic Ulceration of the Esophagus. Bernard S. Wolf, Richard H. Marshak, and Max L. Som. Am. J. Roentgenol. **79**: 741–759, May 1958. (Mount Sinai Hospital, New York 29, N. Y.)

Peptic esophagitis usually of mild degree is frequently seen in association with a hiatus hernia of the direct variety. In the presence of a duodenal ulcer or excessive gastric acidity and hypersecretion for some other reason, or as a result of intubation and operative intervention under general anesthesia, peptic esophagitis of severe degree involving a considerable portion of the distal esophagus may occur and may result in marked stricture formation.

There are some patients in whom a variable length of the distal esophagus is lined by an atypical or embryonic

or heterotopic type of epithelium, which is also susceptible to inflammation and ulceration, presumably under the influence of acid gastric juice regurgitated from the stomach. An ulceration in such a gastric-lined segment of esophagus may resemble an ordinary chronic peptic ulcer. In the absence of an inflammatory complication, a gastric-lined segment of the esophagus is not recognizable by roentgen methods and may also be overlooked at esophagoscopy.

In the presence of a direct hiatus hernia, peptic ulceration of discrete nature may occur in and be localized to the terminal portion of the esophagus without remarkable diffuse involvement of the distal esophagus and independent of gastric hyperacidity. When discrete ulceration is found in the terminal portion of the esophagus in association with a hiatus hernia, the possibility of an atypical type of epithelium must be kept in mind.

Roentgen examination in the severe form of diffuse peptic esophagitis shows a somewhat straightened segment, 5 to 10 cm. long, in the distal esophagus which is markedly narrowed, with irregularly serrated and indistinct contours. Proximally, the esophagus is moderately dilated and characteristically joins the narrowed segment in a fairly abrupt tapering fashion. No niche or projecting ulcer crater is present. The mucosal pattern is distorted, and small, irregular tertiary contractions may be noted within the narrowed segment and its caliber may vary slightly from day to day. In the case of peptic esophagitis associated with a sliding hernia, roentgen changes are not always demonstrable. In some instances, the esophagus for a variable distance proximal to the esophagogastric junction may be incompletely distensible in the sense that the contours remain straight with slight funneling distally. The usual smooth curvatures of the esophagus are obliterated and it may appear to be taut. The peristaltic stripping action at the end of swallowing is inefficient, leaving behind a mottled, irregular column of barium. The barium fails to adhere to the esophageal contours or to outline distinct linear folds.

In the later stages of peptic esophagitis, particularly in the severe type, fibrotic stenosis or stricture may occur in the distal esophagus. The esophagus proximal to a stricture shows moderate dilatation which does not reach the extent seen in severe cardiospasm. In association with a stricture, there is often chronic or recurrent ulceration which may be difficult or impossible to recognize on roentgen examination.

Forty-five roentgenograms; 2 diagrams.

ALFRED O. MILLER, M.D.
Louisville, Ky.

Studies of Esophageal Varices Before and After Portacaval Shunts. John A. Evans and Mary Ann Payne. Am. J. Roentgenol. **79:** 760–767, May 1958. (New York Hospital, 525 East 68th St., New York 21, N. Y.)

Sixty-eight patients had roentgenologic examination for esophageal varices before and after a venous shunt for portal hypertension. Fifty-seven patients had a portacaval shunt, 9 a splenorenal shunt, and 2 patients a shunt utilizing smaller mesenteric veins.

The early diagnosis of esophageal varices requires the recognition of minor alterations in the contours and mucosal pattern of the lower esophageal segment. Varices may produce marginal scalloping similar to that seen in tertiary contractions and may on occasion provide some diagnostic difficulty. Small varices may at first produce only subtle changes in the mucosal pattern. The sharp linear arrangement of the mucosal folds is replaced by a shallow waviness and the spaces between the folds become widened. Later there may be a loss of mucosal definition resulting in a mottled appearance. As the varices enlarge, the typical blotchy, polypoid radiolucent defects in the mucosa appear. In certain cases gastric varices may be the dominant component of gastroesophageal varices and without examination of the stomach the diagnosis may be missed. Varices may produce contour changes of the gastric cardia and fundus similar to those caused by neoplasm.

For 45 patients with a postcaval shunt the results are reported. With a single exception, all had at least one significant hemorrhage prior to operation. The portal pressure was reduced in most instances to between 15 and 20 cm. In all but 5 cases esophagrams showed a disappearance of the varices following the shunting procedure. In 3 of the 5 patients with persistent varices hemorrhage recurred. Of the 11 patients with splenorenal and superior mesenteric to caval shunts, 6 bled postoperatively. In all types of shunt the correlation between subsequent bleeding and persistence of demonstrable varices was striking.

Twenty-nine roentgenograms; 3 graphs.

ALFRED O. MILLER, M.D.
Louisville, Ky.

Pattern of Esophageal Motility in Diffuse Spasm. Brian Creamer, F. Edmund Donoghue, and Charles F. Code. Gastroenterology **34:** 782–796, May 1958. (Mayo Clinic, Rochester, Minn.)

Intraluminal esophageal pressures obtained with water-filled balloons were determined in groups of patients with symptomatic and asymptomatic diffuse esophageal spasm. These pressures are compared with similar measurements made in healthy patients as well as in patients with symptoms suggestive of diffuse esophageal spasm but without roentgen evidence of this abnormality.

Intraluminal pressures of the esophagus and its sphincters, measured at rest and during deglutition in 16 patients with roentgen evidence of diffuse spasm of the esophagus, showed a specific abnormal pattern in every patient. Normal peristalsis was present in the upper part of the esophagus, but in the lower part the peristaltic wave of deglutitive pressure was replaced by a simultaneous and prolonged rise of pressure. These abnormalities were exaggerated by volume stimulation of the esophagus. When asymptomatic diffuse spasm occurred, there was found the same abnormal pattern of esophageal contractions, although the contractions were less simultaneous and of shorter duration than in the patients with symptoms.

In a group of 58 patients with symptoms suggestive of diffuse spasm, but without roentgen evidence of this condition, 16 were found to show the abnormal pattern of deglutitive pressures. The abnormality was similar to that found in the patients with roentgen changes, but it was localized to a shorter area of the lower part of the esophagus. There was no correlation between the pressure records and the type of symptoms present, whether pain or dysphagia or both.

The authors believe that the abnormal pattern found with dry swallows is merely an indication of the motor derangement and that, with the distensive stimulation

to the esophagus caused by eating a meal, the physiologic disturbances are more profound.

Ten graphs; 3 tables. RICHARD A. ELMER, M.D.
Atlanta, Ga.

Cineroentgenography of the Intestine with Special Reference to the Effect of Stimulating Agents Upon Motility. S. O. Liljedahl, O. Mattsson, and B. Pernow. Acta radiol. **49:** 348–354, May 1958. (Karolinska Sjukhuset, Stockholm, Sweden)

The authors used an image intensifier combined with a 35-mm. cine-camera in the investigation of certain drugs upon the motility of the intestine in 11 patients.

The image intensifier with cine-camera needs about 25 milliroentgens for every frame exposed. The surface dose per minute for the type of examination done did not exceed 20 r. The irradiated field was moved as the contrast material was followed, and thus the total skin dose was distributed over the abdomen. The length of the cinematographic exposure did not exceed two minutes, and was made up of a series of exposures in periods of five to fifteen seconds with sixteen exposures per second.

The authors illustrate the contractions of the small bowel as a result of the stimulating agents.

Thirty-two roentgenograms.

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Traumatic Oesophageal Perforation. Report of Three Cases. Ronald R. Gilfillan. Brit. J. Surg. **45:** 623–625, May 1958. (Royal Infirmary, Dundee, Scotland)

Three cases of traumatic perforation of the esophagus are presented. The author offers the following suggestions as to management:

Lipiodol swallow should never be omitted as it is the only sure means of localization. Roentgenograms should also be taken, since there may be little time for dark adaptation before fluoroscopy.

A barium meal is contraindicated in moderate or severe dysphagia. Esophagoscopy should precede it or, failing this, some such medium as Lipiodol which will not obstruct the endoscopic field should be used.

The complication rate in esophagoscopy is very low, but the procedure is preferably undertaken where adequate facilities are available.

Operative treatment should not be delayed. Conservative management is seldom successful.

The Oesophagus in Pneumomediastinography. Milan Svoboda. Radiol. clin. **27:** 161–169, May 1958. (Department of Radiology, Institute of Haematology and Blood Transfusion, Prague, Czechoslovakia)

The author has used pneumomediastinography for demonstration of the esophagus. With the help of a standard intravenous needle, gas (nitrogen monoxide) is injected retrosternally—300–500 c.c. if only the cervical esophagus must be seen, 600–1200 cc. if the thoracic segment is to be inspected. The usual barium mixture is then given, followed by routine fluoroscopy, spot-films, and roentgenographic evaluation, with the addition of planigrams if necessary. The procedure is attended by some discomfort (such as retrosternal pressure) and dysphonia, due to subcutaneous emphysema, but little risk is involved. In the fifty cases in which the method was used by the author, no serious accidents occurred. Several illustrative instances are included in the paper.

Ten roentgenograms. E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

A Special Procedure for Combined Survey of the Whole Gastrointestinal Tract Including the Appendages. E. A. Zimmer. Am. J. Roentgenol. **79:** 866–871, May 1958. (Roentgen-Institute Aarbergerhof, Berne, Switzerland)

The author describes a method whereby it is possible to visualize the gallbladder, stomach, small and large intestine, and often the appendix, in a space of six hours, by employing a combination of a contrast medium which is concentrated in the gallbladder and a very finely pulverized barium, suspended in water and administered by mouth. The dose of the gallbladder medium is 4.5 grams (active principle) added to 125 gm. of a special barium, called Barium Wander, in 500 c.c. of water. The gallbladder medium absorption is apparently stimulated by ingestion of the water, and reasonably good concentration is obtained. The stomach is examined as usual, spot-films of the duodenal cap and loop are obtained, and serial films are taken of the small bowel. A half-hour film usually will demonstrate the entire small bowel and the ileocecal area, and often the appendix. A six-hour film will show the colon well filled with barium. At six hours, also, the gallbladder is well visualized. If it is desirable to study the relationship of the gallbladder, colon, and duodenal cap simultaneously, ordinary barium may be administered by mouth at this time. This method has the advantage of being rapid and economical in the use of films. It may well be suited for mass surveys.

[Gianturco has described a method of one-day examination of the entire intestinal tract and, if necessary, the urinary tract also, which to the reviewer's mind is superior to that reported here. It should also be pointed out that the examination of the entire intestinal tract is no great feat, any number of combinations having been used for that purpose. These differ from the present method in a single respect, namely, that the gallbladder medium is given the night before and the films are obtained preceding barium administration.—P. M.]

Eight roentgenograms. PAUL MASSIK, M.D.
Quincy, Mass.

The Role of Water Soluble Contrast Media in Gastrointestinal Tract Obstruction. Robert M. Lowman and Leonard Davis. Surg., Gynec. & Obst. **106:** 567–572, May 1958. (Grace-New Haven Community Hospital, New Haven, Conn.)

The use of conventional barium mixtures in surgical cases involving the gastrointestinal tract is occasionally contraindicated because of the hazards of impacted barium or peritoneal spillage during operation or of inspissated barium in the postoperative period. To obviate these objections, the authors sought a safe aqueous opaque material. With this in mind, diatrizoate sodium was obtained as Hypaque Sodium in powdered form in 25-gram vials and utilized in 10 to 20 per cent aqueous solution.

The study was conducted over a nine-month period in Grace-New Haven (Connecticut) Hospital and included 50 patients in whom barium was considered to be contraindicated by the referring physician. Among the conditions represented were gastric obstruction by

cancer or benign ulcer, diverticulitis, small bowel obstruction, colitis, and cancer of the large bowel. In 15 cases surgery followed within twenty-four hours of administration of the contrast solution. The aqueous mixture was given to the patients either by mouth (21 patients) or as an enema. Good diagnostic contrast resulted and there was no evidence of iodinism or other side reactions during the study.

The authors believe that the use of water-soluble Hypaque appears to present a method of choice in the radiographic evaluation of gastrointestinal obstruction when the use of conventional media is contraindicated.

Twelve roentgenograms.

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Roentgen Studies of the Fine Gastric Mucosal Relief. II. Study Technic, Contrast Medium Problems, Diagnosis of Chronic Gastritis, Relief Pattern Technic in the Search for Antral Carcinoma. W. Frik. Fortschr. a. d. Geb. d. Röntgenstrahlen **88:** 546–557, May 1958. (In German) (Medizinische Universitätsklinik Erlangen, Germany)

Demonstration of the fine mucosal relief of the stomach is achieved with the aid of compression which must be strong enough to efface the rugal folds. The mucosal relief is demonstrable in 50 to 60 per cent of all patients. Adiposity and tense abdominal muscles preclude its successful visualization because of lack of compressibility.

Differences in thickness of thin barium layers of 0.5 mm. are radiographically apparent. Unibaryt C proved to be the preferred contrast medium. It is prepared by mixing with water of 40° temperature, at low speed, for twenty minutes directly before the examination.

Four patterns of progressive degrees of coarseness were differentiated. The coarser patterns can be effaced by compression with difficulty only or not at all. Transitions to verrucoid and polypoid forms occur. The author did not have gastroscopic findings of his own available for comparison with the roentgen examinations. The incidence of the patterns agreed, however, with that obtained in gastroscopic biopsies by another writer. Atrophic gastritis and coarse, irregular mucosal relief were found with similar frequency in patients over forty years of age. The incidence of hypoacidity and anacidity appeared to correspond to the incidence of that pattern. The finer patterns—"fine-corn" and "delicate" relief—occurred predominantly in the group below forty years of age.

At the present time no definite correlation of gastritis and the mucosal patterns is established, but the normal gastric mucosa is apparently associated with the "fine-corn" and "delicate" patterns. The state of contraction of the submucosa appears to play little part in the type of mucosal pattern since the same pattern persists in a patient on different occasions.

The method described supplements the conventional examination using "graded" compression, particularly in case of early neoplastic changes in the mucous membrane of the stomach. In patients with gastric carcinoma the coarse irregular pattern was found to predominate.

Eleven roentgenograms; 1 diagram; 3 tables.

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Carcinoma of the Stomach. Charles A. Flood. Ann. Int. Med. **48:** 919–955, May 1958. (180 Fort Washington Ave., New York 32, N. Y.)

The present review is an attempt to summarize various aspects of the problem of carcinoma of the stomach which concern the internist. The environmental and racial characteristics as well as incidence are discussed at some length. Next, the early clinical symptomatology and laboratory findings are evaluated.

Radiologic examination is the chief method for the establishment of the clinical diagnosis. Some x-ray findings may be classified as pathognomonic or highly suggestive of cancer. Others are consistent with malignant disease but may also occur in various benign disorders. Finally, the radiologic examination may be essentially negative.

The presence of a filling defect is as a rule convincing evidence of a neoplasm. Irregular mucosal destruction in the stomach, demonstrable roentgenologically, is also indicative of cancer. This radiologic sign is found with malignant infiltration of the gastric wall.

Among radiologic signs which may suggest the possibility of cancer are ulcer craters, relative loss of distensibility of the gastric wall, narrowing of the antrum, and, at times, wide irregular mucosal folds. Such changes are usually also consistent with benign disease.

Cancer may be present in any part of the stomach but fail to be demonstrated by radiologic methods. Lesions of the fundus may be particularly difficult to identify, since the rib margins interfere with palpation by the radiologist. The largest proportion of lesions not seen by x-ray are of the infiltrating type. Ulcerating and polypoid carcinoma and linitis plastica are also occasionally present in patients with normal roentgen findings.

Gastroscopic examination and cytologic study of the gastric contents are the other chief methods for the establishment of the diagnosis of gastric cancer. Cytodiagnosis has attained a rather high degree of reliability, a number of authors having reported an overall accuracy of approximately 80 per cent.

In considering the differentiation of gastric cancer and benign peptic ulcer it is advantageous to classify separately ulcer craters found by x-ray examination in the body of the stomach, at or near the lesser curvature, from craters situated in the antrum or on the greater curvature. The former type, located on or near the vertical portion of the lesser curvature proximal to the incisura angularis, proves to be malignant in 10 to 20 per cent of patients who present this finding. If the niche projects well beyond the contour of the lesser curvature of the stomach the lesion is probably benign. Crater shadows which do not project beyond the general contour of the lesser curvature are suggestive of malignancy. When a crater shadow presents a concave surface facing the gastric lumen (meniscus sign), the possibility of cancer is strongly suggested. Irregularities in the margins of a crater shadow are also suggestive of a malignant process. Very large crater shadows (more than 2.5 cm. in diameter) are more often due to malignant than to benign disease. Exceptions to all of these x-ray criteria may be encountered. Gastric analysis using histamine stimulation should be performed routinely. If absence of free hydrochloric acid is reliably documented, it may be assumed that the lesion is malignant.

The most useful method for differential diagnosis of crater shadows in the upper two-thirds of the stomach is

serial x-ray examination performed during an intensive trial of ulcer therapy, with observation of the rate and extent of healing. The second x-ray examination should be performed after approximately three weeks of therapy. The average healing time of a benign ulcer crater is about six to eight weeks after the initiation of conservative treatment. However, variations are wide. Some craters vanish within two weeks.

Ulcer craters in the antrum differ from ulcers in the body of the stomach in several respects. They are frequently associated with other abnormalities in antral contour, including spastic narrowing and irregularities in one or both curvatures of the antrum. If no deformity is present initially, various changes often develop during a course of observation and treatment of an ulcer in that location. A reversion to a normal x-ray picture after an interval of medical therapy usually cannot be anticipated even if the lesion is a benign one. Gastric analysis may at times be of aid in the differential diagnosis between benign and malignant antral disease. If there is radiologic evidence of ulceration, the finding of histamine achlorhydria indicates malignancy.

The patient with x-ray evidence of wide folds in the stomach may also present a problem in differential diagnosis. The radiologic demonstration of wide gastric rugae at times suggests the possibility of infiltration of the gastric wall either by carcinoma or the rarer gastric neoplasms. Such folds may assume a polypoid appearance. They may be distributed diffusely throughout a large part of the stomach or may appear as localized collections of wide rugae. This type of radiologic picture also occurs quite commonly in the absence of malignant disease, and the nature of the process is often in doubt.

Current figures for the five-year cure rate for carcinoma of the stomach reported from the large private clinics fall roughly between 5 and 10 per cent of all patients admitted to the hospital for carcinoma. The most important factor in prognosis is the presence or absence of lymph node metastases at the time of operation. When no metastases are found, subtotal resection results in a five-year survival rate which ranges between 40 and 50 per cent. Prognosis is affected by the location of the lesion. Patients with growths located high in the fundus or at the cardia usually have a poor outlook. Patients with growths situated in the pars media apparently have a slightly better than average outlook.

Gastric resection may also give rise to a variety of symptoms which are usually grouped together under the heading of the dumping syndrome. These various untoward results of operation are problems which may require continuing medical management.

Radiotherapy is generally regarded as of little or no value in the treatment of carcinoma of the stomach. Most cancers of the stomach are highly resistant to irradiation.

The paper constitutes an excellent appraisal of the problem. STEPHEN N. TAGER, M.D.
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Superficial Spreading Gastric Carcinoma: Is It Detectable Roentgenologically? Robert S. Sherman and Daniel Wilner. Am. J. Roentgenol. **79:** 781–785, May 1958. (Memorial Center for Cancer and Allied Diseases, New York 21, N. Y.)

The authors classify neoplastic involvement of the stomach as (1) polypoid, (2) ulcerative, and (3) infiltrative, deep and superficial. This paper deals with superficial infiltrating carcinoma of the stomach. Polypoid or ulcerative lesions provide obvious roentgen features.

Three cases are presented, selected to show progressive stages of gastric wall invasion and the resulting roentgen appearances which, taken together, constitute the authors' concept of the roentgen diagnosis of superficial spreading gastric carcinoma. In the first case radiologic examination of the stomach was negative on two occasions, but operation revealed an adenocarcinoma confined to the mucosa, with submucosal lymphatic permeation. The second case illustrates the incompatibility of radiographic features and gross and microscopic pathologic features. The gastrointestinal series on this patient demonstrated a thinning of the mucosal folds, particularly in the distal portion of the stomach, and a duodenal defect interpreted as an ulcer, associated with functional changes in the prepyloric portion of the stomach. Gastroscopy showed only inflamed mucous membrane. At autopsy the pathologist described thickened gastric walls containing palpable nodules due to a neoplasm which had spread into the duodenum, proved microscopically to be adenocarcinoma of the stomach. The third patient had a constricting lesion at the pyloric end of the stomach indicative of deep wall invasion. At operation the surgeon's opinion was that the carcinoma was so small that its presence was not possible to determine by palpation. After removal of the stomach, the pathologist on gross examination saw no abnormality and the mucosa appeared normal except that the rugae were not prominent. Histologically, however, multiple small foci of superficial adenocarcinoma were found in the mucosa of this part of the stomach. The roentgenologic findings were considerably more pronounced, therefore, than gross inspection of the specimen would have indicated.

These cases illustrate how elusive roentgen diagnosis and gross pathologic diagnosis of carcinoma of the stomach may be. The roentgen findings that may be encountered include depressed peristaltic activity with shallow asymmetric waves coursing through the stomach, diminution in the number of mucosal folds due to an erasure of the smaller rugae and diminished prominence of the larger folds, and alteration of the rugal architecture showing thin indistinct contours. Mucosal motion may be altered, indicating a "freezing" of the thin mucosa so that no parallel fold formation is observed with passage of a peristaltic wave. There may be a funnel-like contour defect but without a palpable mass.

Four roentgenograms. JOHN W. WILSON, M.D.
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Face-on Demonstration of Ulcers in the Upper Stomach in a Dependent Position. Richard Schatzki and John E. Gary. Am. J. Roentgenol. **79:** 772–780, May 1958. (1180 Beacon St., Brookline, Mass.)

Examination of the upper part of the stomach is regarded by many radiologists as difficult, since this portion of the stomach cannot be palpated. This paper is written to illustrate the advantages of dependent positioning, which provides examination of the upper portion of the stomach with comparative ease. The face-on demonstration of ulcers is discussed principally to show how these can be detected and thus to illustrate the advantages of this method of diagnosis.

The principle of the procedure consists of rotating the

patient to positions that remove surplus barium from the areas to be studied. The patient is first placed in a supine position and the barium collects in the fundus. The patient is then rolled toward the right side so that the fundus is emptied and the barium is distributed along a trough formed by the lesser curvature and adjacent portions of the anterior and posterior walls. With this procedure the lesser curvature and adjacent parts of the anterior and posterior walls may be viewed in a face-on projection. At the same time the anterior and posterior walls are silhouetted.

Tilting the table partially upright will cause the barium to be shifted about with minimal degrees of rotation of the patient, providing a "palpation-like" examination of the lesser curvature. The versatility of the procedure depends upon utilizing variable degrees of table tilt and patient rotation. The optimal tilting and rotation will depend upon the shape and position of the stomach in the individual case.

These maneuvers produce a wave of barium across the lesser curvature and the barium remains trapped in any ulcerations, resulting in a face-on demonstration of the crater. Roentgenograms and diagrams are reproduced to show how ulcers may be visualized in-face that cannot be shown in profile. Thus the examination is of use in the discovery of gastric ulcers that may otherwise not be detected. An evaluation of rigidity of the stomach in areas inaccessible to palpation can also be made. The mucosal pattern may be well outlined by this method and the procedure helps differentiate true ulcerations from barium-filled troughs between normal mucosal folds in the cardia and fundus.

Twenty-two roentgenograms; 3 drawings.

JOHN W. WILSON, M.D.
Johnstown, Penna.

Alterations of the Greater Gastric Curvature in the Roentgenogram, with Remarks on Malignant Degeneration of Peptic Ulcer. K. Halbeis and G. H. Marcus. Radiol. clin. **27:** 129–147, May 1958. (In German) (I. Chirurgische Universitätsklinik, Vienna, Austria)

From 1945 to 1955, 17,158 barium-meal examinations were performed in the first surgical division of the University of Vienna. Of these, only 50 revealed changes involving exclusively the greater gastric curvature. In 8 of the 50 the changes were proved to be of benign nature: 1 granuloma, developing within the suture line of a Billroth I operation for gastric ulcer, 1 instance of adhesions following cholecystectomy, 3 cases of benign polyps, and 3 of benign ulcer. During the same time span, a total of 1,807 benign ulcers were found; thus the benign ulcers on the greater gastric curvature represented 0.17 per cent of the total number. If to these 3 one adds the 6 cases of malignant ulcer found among the 50 patients with changes on the greater curvature, the total of ulcers (of both benign and malignant nature) on the greater curvature reaches 9, *i.e.*, over 0.5 per cent.

Among the 42 malignant tumors involving the greater curvature, only 34 were operable; 5 proved to be sarcoma, 4 lymphosarcoma and 1 reticuloendothelial sarcoma. The others were carcinomas, including 2 malignant polyps. One of the 6 malignant ulcers was a lymphosarcoma; the others were carcinomatous.

From 1950 to 1955 there were seen 450 benign gastric ulcers (335 in males and 115 in females). During the same period, there were 73 cases of gastric ulcer with malignant degeneration, an incidence of 17 per cent. During these same years, only 2 among 782 duodenal ulcers were carcinomatous. Among the 73 malignant gastric ulcers above mentioned, only 42 were verified histologically as being the result of change in a previously benign ulcer. By gauging this figure of 42 (or the larger total of 73) against the 647 cases of gastric cancer encountered during this period, one sees that about 10 per cent of malignant gastric tumors result from the "degeneration" of benign ulcers.

So unusual as to deserve a special mention was the distribution of the 42 cases by sex: 26 in males and 18 in females. After discussion of the roentgenologic features, the authors conclude that a positive diagnosis requires histologic examination; all other findings are at best presumptive.

Nine roentgenograms; 2 graphs; 2 tables.

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Primary Hypertrophic Pyloric Stenosis in the Adult. K. Lumsden and S. C. Truelove. Brit. J. Radiol. **31:** 261–266, May 1958. (Radcliffe Infirmary, Oxford, England)

Hypertrophic pyloric stenosis unassociated with any other lesion of the digestive tract is a rare condition in adults. It may cause symptoms after a latent period in a person in whom it was known to be present in infancy, or it may appear for the first time in an adult. A case report of each type is reported by the authors. The first patient, a woman who was treated without surgery for symptoms of pyloric stenosis as an infant, had recurrent attacks of dyspepsia, flatulence, and diarrhea at the age of thirty-eight years. The second patient was a 45-year-old man complaining of bouts of severe chest pain. Each displayed roentgen changes typical of pyloric stenosis and at surgery this was the only lesion found.

Seventeen adults with a history of infantile pyloric stenosis and no symptoms later in life were re-examined. Of these, 5 had definite narrowing of the distal pyloric canal on radiography. Four of the five "positives" were under the age of twenty years, tending to confirm earlier data that the abnormality decreases with advancing years. This phenomenon has been observed following both medical and surgical management of the condition in infancy, but the authors give no indication of the mode of treatment in their series.

Four roentgenograms; 1 photomicrograph; 1 photograph; 1 diagram; 2 tables.

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Displacements of Stomach and Duodenum by Anomalous Lobes of the Liver. Harvey I. Meyers and George Jacobson. Am. J. Roentgenol. **79:** 789–792, May 1958. (G. J., 1200 N. State St., Los Angeles 33, Calif.)

Displacements of the stomach and duodenum and abnormal configurations of the right diaphragmatic leaf should alert one to the consideration of anomalous lobes of the liver in the differential diagnosis. An accessory lobe of the liver may cause a lobated projection of the superior and posterior segment of the right diaphragmatic leaf which is seen frequently in chest radiography. Riedel's lobe, an inferior tongue-like projection of the right lobe of the liver, may present clinically as a mass in the right upper quadrant and may be observed as a mass roentgenographically. An appendicular lobe

producing a defect on the greater curvature of the stomach has also been reported and is cited in this article.

A case is reported in which marked anterior displacement of the duodenum and distal half of the stomach, demonstrated by radiography, was found at operation to be due to a quadrate lobe of the liver beneath the porta hepatis, hypertrophied to 10 cm. in diameter. A second patient presented a large pressure defect along the lesser gastric curvature with anterior displacement of the stomach. Operation disclosed a 20 × 10-cm. mass attached by a wide pedicle to the posterior inferior portion of the left lobe of the liver, and filling the lesser peritoneal cavity; biopsy showed this to consist of normal liver tissue. In a third case a "flopping" of the distal three-fourths of the stomach from a normal left upper quadrant position to a right upper quadrant position was observed fluoroscopically. Operation revealed a long mesentery, which allowed the rotation of the stomach on its long axis, and congenital absence of the left lobe of the liver.

The authors offer these 3 cases of displacement of the stomach and duodenum by an enlarged quadrate lobe of the liver, an anomalous lobe of the liver, and absence of a lobe of the liver, respectively, to illustrate how these abnormalities may simulate pancreatic and retroperitoneal masses and to lead to their consideration in the differential diagnosis of these conditions.

Six roentgenograms. JOHN W. WILSON, M.D.
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A Technique for Filling Part Two of the Duodenum with Particular Reference to the Improvement in Roentgenographic Demonstration of Postbulbar Ulcers. Sidney W. Nelson. Am. J. Roentgenol. **79:** 799–806, May 1958. (Ohio State University Health Center, Columbus 10, Ohio)

Ulcers of the descending limb of the duodenum may not be discovered radiographically because the examiner does not keep the diagnosis in mind or because of the technical difficulty of examination of this portion of the duodenal sweep. The unexpected discovery of such craters at laparotomy has led to the term "duodenal ulcer occulta." Because of severe irritability and spasm associated with post-bulbar ulcers, the crater may not be filled with barium and therefore may not be visualized on routine roentgen examination.

A means of examining the duodenal loop when it is inadequately filled by the routine procedure has been devised by the author. His method relies on compression occlusion of the third portion of the duodenum when the patient is in a prone or prone-oblique position. The occlusion is affected by ordinary gauze pads or balls 5 to 7 inches in diameter placed between the patient and the table so that the patient's weight rests on the pads. If necessary, barium may be forced into the duodenum from the stomach by manual pressure with the gloved hand. Boluses of barium may accumulate distal to the lesion in the descending limb of the duodenum, in which instance the barium can be forced in a retrograde fashion through the diseased lumen by adjusting the position of the gauze rolls. Spot-films are then taken under direct fluoroscopic control. If examination in the prone position does not result in success, the manuever may be tried in an upright position, with a pendulum type of compression device.

The author has found this method useful not only in identifying lesions that are otherwise not recognized but in the differential diagnosis of post-bulbar ulcer, diverticulum or neoplasm. He cautions that patience and manipulation during fluoroscopy are required but feels that the procedure greatly aids the identification of ulcers of the descending limb of the duodenum when routine methods fail.

Fourteen roentgenograms; 1 diagram.

JOHN W. WILSON, M.D.
Johnstown, Penna.

Arteriomesenteric Occlusion of the Duodenum. Walter P. Bitner. Am. J. Roentgenol. **79:** 807–814, May 1958. (234 State St., Harrisburg, Penna.)

A frequent cause of duodenal stasis is occlusion of the third portion of the duodenum by the superior mesenteric artery at the point where it crosses over the duodenum with the superior mesenteric vein and nerve. In 1849 von Rokitansky first described this entity.

The transverse portion of the duodenum is the most fixed part of the gastrointestinal tract. It is located retroperitoneally between the aorta and the lumbar spine (usually L-3) posteriorly and the root of the mesentery of the small intestine which contains the superior mesenteric artery, vein, and nerve anteriorly. In certain cases the right colic artery or the midcolic artery may be responsible for this syndrome.

Mesenteric duodenal occlusion has been reported over a wide age range, from nine weeks to the sixth decade. Symptoms average eleven and one-half years in duration. They include pain, belching, vomiting of bile, vasomotor and neuromuscular disturbances, flatulence and a sense of weight in the abdomen after meals, anxiety and emotional instability.

On physical examination the abdomen is found to be either flabby and pendulous or scaphoid and emaciated. Lordosis and a palpable right kidney are usually present. Pressure over the lower abdomen to lessen the pull on the mesentery and the knee-chest position will sometimes give relief.

The diagnosis of mesenteric artery occlusion of the duodenum can be suspected clinically and confirmed by x-ray studies. The best time for the examination is during an attack. The following roentgen criteria should be met: (1) constant dilatation of the duodenum proximal to the midpart of the transverse portion; (2) normal duodenum distal to this part; (3) retention of barium beyond the normal time limit; (4) to-and-fro movement of the barium within the duodenal loop. Laboratory studies are not diagnostic.

The following should be considered in the differential diagnosis: congenital peritoneal bands, shortening and thickening of the ligament of Treitz, atresia of the distal duodenum, annular pancreas, ptosis of the duodenum, anomalies of malrotation, tumors and cysts of the mesentery, aneurysm of the abdominal aorta, and tumors of various etiology.

When the diagnosis has been made, the initial treatment should be medical (bed rest; relief of vomiting; correction of dehydration, electrolyte imbalance, and nutritional deficiency). After the acute attack subsides, an ulcer regimen can be started. An abdominal support and abdominal and postural exercises are helpful. If conservative measures are unsuccessful, surgical correction is indicated. The procedure of choice is duodenojejunostomy. The psychiatric aspects of the disease are discussed.

Four cases are reported.

Ten roentgenograms. EDWIN KOCH, M.D.
Indiana University Medical Center

The Roentgen Diagnosis of Ileo-Ileal Intussusception. Leo G. Rigler and H. Wilson Godfrey. Am. J. Roentgenol. **79:** 837–842, May 1958. (Cedars of Lebanon Hospital, Los Angeles 29, Calif.)

While ileo-ileal intussusception is of less frequent occurrence than other varieties it has a disproportionately high mortality rate, presumably due to delay in diagnosis. This in turn may be attributed to several factors. First, ileo-ileal intussusception is a subacute, chronic, or chronic recurrent type of process, with episodes of crampy abdominal pain, diarrhea, and chronic weight loss, and a vague history which often goes unrecognized. The second reason for delayed recognition is failure to utilize roentgenologic diagnostic methods, and the third is that roentgen study does not provide the high percentage of positive results obtained in ileocolic and colocolic intussusceptions.

Simple roentgenograms of the abdomen may show signs of partial or complete bowel obstruction, depending upon the duration of the process. While not specifically diagnostic, plain films serve to screen out cases in which intussusception is unlikely. Certain specific signs may be seen, however. A beak-shaped area of radiolucency resulting from the conical narrowing of the intussusceptum is a significant finding. A longer intussusceptum shows a curvilinear radiolucency within a soft-tissue mass, or concentric encircling of the soft-tissue mass may be caused by gas trapped between the walls of the intussusceptum and the intussuscipiens.

In cases with symptoms of the chronic or subacute type, barium given orally, with a follow-up examination of the small bowel, has been useful. Cases thus examined have shown a transient delay of the barium column and narrow streaks of barium passing down the lumen of the intussusceptum for its entire length. The "coiled spring" outline of barium between the walls of the intussusceptum and intussuscipiens is frequently diagnostic. This may also be demonstrated on a barium enema study when reflux occurs into the ileum.

The authors describe a new roentgen sign. A shadow of gas density resembling a bicycle seat in shape, resulting from constriction of the intusssusceptum, was found on the plain film in 1 of the 3 cases which they report.

Three roentgenograms.

JOHN A. CAMPBELL, M.D.
Indiana University Medical Center

Enlargement of the Ileocecal Valve. Charles E. Grayson. Am. J. Roentgenol. **79:** 823–836, May 1958. (1215 28th St., Sacramento 16, Calif.)

The author has correlated the clinical, radiological, surgical, and pathological findings associated with enlargement of the ileocecal valve and reports 10 cases. There is disagreement as to whether or not such enlargement is of clinical significance. No reported group of patients could be found in which the syndrome was localized by the radiologist and in which there was planned definitive surgery with follow-up indicating relief of symptoms.

The normal ileocecal valve is formed by two folds of mucosa, submucosa, and circular muscle which extend several millimeters into the cecum. The causes for enlargement are usually non-specific and include edema, submucosal fat accumulation, herniation of ileal mucosa, tumor, and inflammatory lesions. In most cases there is a combination of inflammation, edema, and fat infiltration of variable proportions, suggesting that fat infiltration may be the end-result of a chronic inflammatory disease.

The symptoms associated with this syndrome are bloating, right-sided abdominal pain, and tenderness at the site of the ileocecal valve. However, ileocecal valve enlargement may produce referred pain in the right upper quadrant, right flank, left upper or lower quadrant, or even the right inguinal region. Symptomatic abnormalities of the ileocecal valve region are relatively common and usually mild in nature. In speaking of enlargement of the valve, reference is made to the lips of the valve and not the orifice. Thickening of the valves should be considered significant only in the presence of localizing symptoms and signs and in the absence of any other cause for abdominal distress. Even though an enlarged ileocecal valve is found on examination, meticulous study must be made to exclude other disease.

Five cases of intermittent relenting intussusception associated with ileocecal valve enlargement are also briefly presented. Ileocecal valve tenderness may occur in many patients with mild degrees of ileitis, or colitis found incidentally at fluoroscopy.

The x-ray examination is very important in the differential diagnosis and as an indication for or against surgery. Study of the ileocecal region should include oral administration of barium as well as retrograde filling of the ileum. Fluoroscopy after evacuation is considered to be the most critical part of the examination because it is done under the most nearly normal physiologic conditions. The referred pain located by pressure over the ileocecal valve is an important diagnostic point.

The differential diagnosis includes appendicitis, nonsclerosing ileitis, regional ileitis, peritoneal adhesions, cholecystitis, and right-sided genitourinary disease with reflex ileus.

If the symptoms are sufficiently severe, ileocecal resection and re-anastomosis have been effective.

Thirty-two roentgenograms; 2 photomicrographs; 3 photographs; 1 table. RODNEY R. MILLION, M.D.
Indiana University Medical Center

The Preoperative Roentgen Diagnosis of Meckel's Diverticulum in Adults. George N. Stein, Hugh H. Bennett, and Arthur Finkelstein. Am. J. Roentgenol. **79:** 815–822, May 1958. (Graduate Hospital of the University of Pennsylvania, Philadelphia 46, Penna.)

Although Meckel's diverticula are frequently seen at autopsy and at operation, the roentgen diagnosis is rarely made. The authors report 4 cases in which a roentgen diagnosis was made prior to operation and a fifth case diagnosed roentgenologically but not yet operated upon. Thirty-three cases recognized preoperatively have previously appeared in the English literature.

Roentgen diagnosis can be made by serial barium examination of the intestinal tract, with primary reliance upon large films of the small intestine, fluoroscopy being used where necessary for spot-films and specific localization. Meckel's diverticulum is usually found in the terminal ileum between 1 and 3 feet from the ileocecal valve. This differentiates it from intestinal duplication, which occurs anywhere in the intestinal tract. Duplication also differs in that it occurs on the mesenteric side of the intestine while Meckel's diverticulum characteristically arises on the antimesenteric side.

A Meckel's diverticulum may be asymptomatic or there may be abdominal pain, intestinal bleeding, intestinal obstruction, and intestinal perforation. These symptoms result from one of the following pathological changes involving the diverticulum: acute inflammation, peptic ulcer, foreign body, neoplasm, intussusception, knots of the diverticulum, internal or external hernias, volvulus of the intestine around the diverticulum.

Eight roentgenograms; 3 diagrams.

PAUL MASSIK, M.D.
Quincy, Mass.

An Assessment of the Accuracy of the Clinical and Radiological Diagnosis of Carcinoma of the Colon. J. M. Allcock. Brit. J. Radiol. **31**: 272–277, May 1958. (Radio-diagnostic Department, Addenbrooke's Hospital, Cambridge, England)

The author reviews the literature on the accuracy of x-ray examination of the colon as a means of diagnosis of cancer. His own series numbered 200 proved cases. Plain films of the abdomen were obtained in 49 cases, of which 39 were reported as showing signs of colonic obstruction, although this was not always located accurately. One hundred and twenty-three patients were examined by barium enema, and in 109, or 89 per cent of these, a diagnosis of carcinoma or probable carcinoma was made. In another 7 per cent the lesion was shown but the appearances were wrongly interpreted, and in 4 per cent the neoplasm was missed.

The finer points in arriving at these percentages are worked out in 6 tables. SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

Fistulous Tracts with Intestinal Communication Secondary to Abscess Formation in Diverticulitis. Charles E. Bickham, Jr. Am. J. Roentgenol. **79**: 854–861, May 1958. (1835 Eye St., N. W., Washington 6, D. C.)

Eight cases of fistulous tracts between the colon and the small bowel or between two portions of the colon are reported, all due to diverticulitis, with abscess formation. In 6 patients the original abscesses had drained through sinus tracts which paralleled the colon and pierced the lumen at multiple points. The fistulas varied in length from 5 to 14 cm., and occurred either in the subserosa or submucosa, the subserosal site being more common. Roentgenologically there was evidence of chronic diverticulitis with deformity, scarring, and often shortening of the colon. The enterocolic fistulas filled with barium during administration of a barium enema.

Treatment is generally surgical, although in 2 cases conservative therapy resulted in improvement.

Twelve roentgenograms; 1 photograph.

PAUL MASSIK, M.D.
Quincy, Mass.

Diverticulitis of the Cecum and Right Colon: Clinical and Radiographic Features. Report of 18 Cases. Adolfo Schapira, Julius J. Leichtling, Bernard S. Wolf, Richard H. Marshak, and Henry D. Janowitz. Am. J. Digest. Dis. **3**: 351–383, May 1958. (Mount Sinai Hospital, New York, N. Y.)

The authors reviewed case material at Mount Sinai Hospital (New York) during the period 1933 to 1956 and discovered that diverticulitis of the cecum and right colon was probably more common than the literature would indicate. The purpose of this study is to present 18 cases of this entity, to emphasize its clinical features, and to discuss the radiographic and therapeutic aspects of the disease.

Data were obtained which do not support the postoperative traumatic theory of cecal diverticula. Also, the commonly held concept that most cecal diverticula are solitary is not valid. It is more likely that one of many diverticula present becomes inflamed and symptomatic. In 10 of 18 cases the existence of more than one diverticulum was demonstrated either by x-ray or pathological study or both. An extensive list of differential diagnoses is given and it is stated that frequently the diagnosis cannot be established prior to laparotomy.

Treatment has most often been surgical, although many cases of cecal diverticulitis probably subside with nonoperative supportive therapy. Surgery has been widely practiced due to confusion of the lesion with appendicitis. The operative treatment of choice in cecal diverticulitis is one that is conservative yet adequate. Supplementary appendectomy is advised if it can be easily performed.

The familiar roentgen findings of diverticulosis, single diverticulum, and diverticulitis are described in detail.

Twenty roentgenograms; 18 radiographs.

CAPT. BYRON G. BROGDON, USAF (MC)
Parks AFB, Calif.

Evaluation of a New Colon Evacuant, Dihydroxyphenylisatin. Howard J. Barnhard and Neil E. Crow. Am. J. Roentgenol. **79**: 876–880, May 1958. (University of Arkansas Medical Center, Little Rock, Ark.)

The authors report the use of a new nonabsorbable chemical, dihydroxyphenylisatin, which stimulates colonic evacuation by direct action on the mucosa. Marketed in Great Britain as Veripaque, it is supplied in this country as Lavema (Winthrop Laboratories).

This preparation was used in cleansing and barium enemas in 162 patients. It was not found to be advantageous as an addition to the barium enema, either as a substitute for or supplement to tannic acid. It acted, however, as a satisfactory cleansing agent preparatory to intravenous pyelography and other abdominal procedures. It should not be used in preparation for barium enema studies, as the subsequent mucosal detail is poor.

Two liters of a solution in *distilled* water, 10 to 20 mg. Lavema per liter, will result in satisfactory evacuation in twenty-five to thirty minutes. Tap-water solutions produce cramping, nausea, and vomiting.

Four roentgenograms; 1 table.

PAUL MASSIK, M.D.
Quincy, Mass.

Radiologic Findings and Pathological Anatomy in Terminal Choledochitis. Marcel Roux, Ch. Debray, R. Le Canuet, and R. Laumonier. J. chir., Paris **76**: 116–136, June-July 1958. (In French) (l'École de Médecine de Paris, France)

The most frequent lesion at the lower end of the common duct is a fibro-muscular-glandular nodule at the ampulla with intact adjacent duodenal mucosa, absence of acute or subacute inflammation, and anomalies of the nerves, which are usually less developed than in the duodenal wall. This nodule can be seen but rarely when the duct has been visualized by means of oral or intravenous media, but its presence can be

suspected when the duct is dilated, its lower end does not fill, or it rounds off like the tip of a finger.

Operative or postoperative cholangiograms enable one to study the pathologic images, which are of two orders: (1) an abnormal aspect of the slender strait which corresponds to the sphincter, (2) an unusual junction of the sphincteric zone with the common duct.

The sphincteric segment is composed of three parts: (*a*) a nearly straight tubular superior segment; (*b*) a lozenge-shaped or triangular middle segment corresponding to the pancreatic duct; (*c*) a filiform, nearly invisible segment masked by the duodenal folds.

The superior segment is often affected by the dilatation of the duct above, and the junction may be shaped like the tip of a small test tube, a pestle, or a twisted nail, or be distinctly narrowed, funnel-like, or hooked. Reflux into the pancreatic duct is rare normally, but is frequent in disease, with the pattern resembling a short filled segment, or a pearl on the common duct. The sphincteric segment may be displaced or be pathologically deformed by the intruding nodule.

Twenty-four figures, including 16 roentgenograms.

FRANK A. RIEBEL, M.D.
Columbus, Ohio

HERNIA

The Occurrence of Hiatus Hernia and Insufficiency of the Cardia in Association with Pleural Thickening. Otso Kuosmanen. Acta radiol. suppl. 153, 1957. (In German) (Wihuri Research Institute, Helsinki, Finland)

The author previously described 7 cases of hiatus hernia in patients with left-sided pleural thickening (Pätiälä, Kuosmanen, and Salmenkallio: Ann. chir. et gynaec. Fenniae **44:** 77, 1955). In the present study he has attempted a correlation between hiatus hernia, as well as insufficiency of the cardia, and left-sided pleural thickening.

The study included: (1) examination of 200 known cases of pleural thickening; (2) control observations on 807 consecutive patients without pleural thickening, who came to examination because of various symptoms; (3) an investigation of 205 autopsied cases in which measurements of the hiatal opening of the diaphragm were made and analyzed as to the presence or absence of pleural thickening.

Of the 200 patients with pleural thickening, 144 had pulmonary tuberculosis, which was treated with pneumothorax, 50 had pleurisy, and 6 had experienced trauma to the chest in one form or another.

The incidence of hiatus hernia and insufficiency of the cardia was significantly higher in patients with pleural thickening (12 per cent in the hiatus hernia series and 16 per cent in insufficiency of the cardia) than in the controls (4 per cent and 4 per cent). The average age in the control group was higher than in the series under study. Of the 200 patients with pleural thickening, 148 had no symptoms, yet 15 of these had a hiatus hernia.

Right sided pleural thickening did not produce an increased incidence of either hiatus hernia or insufficiency of the cardia when compared to the control group. If the posterior left costophrenic sulcus was obliterated, a considerably higher incidence of insufficiency of the cardia occurred (30 per cent), while no significant increase in hiatus hernia was seen. Displacement of the mediastinal structures secondary to pleural thickening did not affect the incidence of the two conditions under consideration.

The origin of the pleural changes, or the duration of pneumothorax, did not have an effect on the incidence of either hiatus hernia or insufficiency of the cardia. No significant relationship could be established between the incidence of the two conditions and the time of occurrence of the pleural thickening.

In analyzing the findings in 205 medicolegal autopsied cases, the author found that the incidence of an enlarged hiatus, admitting 3 or 4 fingers, was significantly greater in cases with pleuro-diaphragmatic adhesions than in cases without adhesions (62 per cent against 21 per cent). Forty-three per cent of cases with right-sided adhesions showed widening of the hiatus as compared to 80 per cent of those with left-sided or bilateral adhesions.

No definite cause can be offered for the statistically significant association of hiatus hernia and pleural thickening The author suggests that the explanation lies in the fact that the hiatus is usually formed by a muscular loop originating from the right crus. Traction caused by the pleural thickening would have a tendency to widen the hiatus.

Nineteen figures; 22 tables.

ALEXANDER R. MARGULIS, M.D.
University of Minnesota

THE MUSCULOSKELETAL SYSTEM

Vitamin-D-resistant Osteomalacia. W. P. U. Jackson, E. Dowdle, and G. C. Linder. Brit. M. J. **1:** 1269–1274, May 31, 1958. (Groote Schuur Hospital, Capetown, Union of South Africa)

Vitamin-D-resistant osteomalacia is a relatively rare condition in adults. Two theories of pathogenesis are entertained: Albright and Reifenstein (The Parathyroid Glands and Metabolic Bone Disease, Williams & Wilkins Co., Baltimore, 1948) attributed the condition to a resistance to the normal effect of vitamin D on intestinal absorption of calcium, while McCune *et al.* (Am. J. Dis. Children **65:** 81, 1943. Abst. in Radiology **43:** 96, 1944) held to the concept of a primary loss of phosphorus *via* the urine due to diminished renal tubular reabsorption. The authors discuss these theories and themselves suggest another possibility—namely, that there is more than one variety of resistant osteomalacia, with more than one basic pathogenesis.

A single case is reported, with a complete work-up from both laboratory and roentgen standpoints. Generalized osteoporosis was seen, along with the deformities characteristic of adult rickets—inward protrusion of the acetabula, kyphoscoliosis, knock knees, and pigeon breast deformity. Very pronounced Looser's zones were noted in the shoulder girdles, ribs, pelvis, and mandible.

The relation of the arteries to the Looser's zones in the pelvic bones was investigated by transaortic arteriography, since it has been claimed that these are caused by the pulsation of vessels lying on or near bone (Steinbach: Radiology **62:** 388, 1954). The zones were not found to coincide with arteries closely enough to support this view. Some zones which were quite broad were well removed from any significant arteries.

Four roentgenograms; 1 photograph; 2 diagrams; 5 graphs; 3 tables. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Pulmonary Hypertrophic Osteoarthropathy (Periostitis): Its Absence in Pulmonary Tuberculosis. Alan B. Skorneck and Leonard B. Ginsburg. New England J. Med. **258:** 1079–1082, May 29, 1958. (VA Hospital, West Haven, Conn.)

The term pulmonary hypertrophic osteoarthropathy as used in this paper refers to the roentgenographically demonstrable changes of bone and soft tissue that occur in association with, or as a result of, pulmonary disease. These changes are distinct from the physical finding of clubbing, a term that should apply only to the soft-tissue and nail alterations in the fingers and toes. Clubbing is rarely accompanied by symptoms and is usually discovered on routine physical examination. Pulmonary osteoarthropathy, on the other hand, may cause symptoms ranging from mild aches to severe pains in the region of the affected bones and nearby joints. It is usually not detected unless it is symptomatic and the examining physician is curious enough to obtain roentgenograms.

Pulmonary osteoarthropathy is primarily a periostitis of bone showing rather characteristic roentgen and pathologic features. It is seen commonly along the distal radius and ulna and the distal tibia and fibula, chiefly on the lateral margins. Bone layers may reach the thickness of 1 cm. of more. In addition, the terminal phalanges show soft-tissue changes of clubbing. The condition has been described as occurring in 5 to 10 per cent of cases of carcinoma of the lung and appears in primary pleural tumors, bronchiectasis, lung abscesses, empyema, and, rarely, in cyanotic heart disease. It is reported to occur in cholangiolitic biliary cirrhosis, liver abscesses, and in chronic diarrheal states including ulcerative colitis, regional enteritis, and intestinal polyposis.

Over a period of three years, the authors studied roentgenograms of the hands and lower legs of 390 patients newly admitted to the tuberculosis service of a Veterans Administration hospital. Almost all patients had active disease and many were transferred from other tuberculosis hospitals after prolonged confinement. It was found that *no* patient with active tuberculosis had pulmonary hypertrophic osteoarthropathy. Three cases were uncovered incidentally in patients with a presumptive diagnosis of pulmonary tuberculosis but the final diagnoses were lung carcinoma in 2 and pyogenic abscess in 1. Rarely, pulmonary osteoarthropathy may develop in complicated thoracic tuberculosis, such as empyema.

Given a case of lung disease, the discovery of pulmonary osteoarthropathy (periostitis) by roentgen examination of the extremities militates against a diagnosis of tuberculosis.

Two roentgenograms; 1 table.

JOHN A. CAMPBELL, M.D.
Indiana University Medical Center

Skeletal Manifestations of Gaucher's Disease with Some Unusual Findings. B. Strickland. Brit. J. Radiol. **31:** 246–253, May 1958. (Westminster Hospital, London, S. W. 1, England)

Four cases of Gaucher's disease are presented, with illustrations, preceded by a brief review of the pertinent features of this rare familial disorder. The disease is probably transmitted as a recessive and is seen at all ages, tending to run a more acute course in infants and children. The characteristic Gaucher's cell is an altered reticulum cell which contains a lipid, kerasin, due to an abnormality of metabolism which apparently exists within the cell itself. These large foam cells eventually become very widespread, packing the spleen, liver, and sometimes the lymph nodes; in a fully developed case almost every bone may be microscopically involved, a feature which makes marrow puncture the customary method of diagnosis. The most common presenting symptoms are abdominal swelling and a dragging sensation in the loin due to the enlarging spleen. Yellow-leaden pigmentation of the skin, usually symmetrically distributed, is seen in about 60 per cent of cases. The pigment is thought to be hemosiderin. Hemorrhagic episodes are common and, although the circulating blood does not contain characteristic cells, there is a decrease in its normal elements which reflects the bone involvement.

On roentgenograms the Erlenmeyer flask deformity of the distal femur is common, but is not characteristic of this disease alone. The medullary canal may be widened, with irregular areas of rarefaction. The bony cortex may be thin, even in the absence of medullary expansion. Pelvic lesions are uncommon, and isolated defects in the skull are rare, an important feature in differential diagnosis. Pathologic fractures can occur, particularly in the spine and weight-bearing bones. Another complication is aseptic necrosis of the femoral head and neck, presumably due to masses of Gaucher cells in or about the smaller blood vessels. In long standing cases one may see superimposed sclerotic changes in the involved bones. These have been explained as metaplasia of the reticular fibers and also as evidence of a reparative process near areas of destruction.

In one of the author's patients focal periosteal reactions developed along the shafts of long bones. Although this was probably not a true inflammatory change, it simulated the periostitis of infection. A third patient sustained two pathologic fractures of the femur in areas where the bone appeared radiographically normal. Skeletal survey films of 5 other cases, all in children under ten years, presented no evident bony abnormality.

Eleven roentgenograms.

LAWRENCE A. POST, M.D.
University of California, S. F.

Spondylitis Caused by Salmonella typhimurium. Rasmus Stenström. Acta radiol. **49:** 355–360, May 1958. (Aurora Hospital, Helsinki, Finland)

The author presents a case of acute spondylitis in association with an infection by *Salmonella typhimurium.* One month after the onset of symptoms the patient experienced pain in the back and numbness in the legs, and roentgen examination demonstrated spondylitic changes in the second to fifth lumbar vertebrae. The height of the intervertebral disk between L-5 and S-1 was normal, but the lower margin of L-5 was blurred. Two weeks later the joint space had diminished and destruction of the articular surfaces was apparent. Later examinations demonstrated rapid regression of the vertebral changes, with bony fusion of the posterior parts of the vertebrae.

The majority of cases of typhoid and paratyphoid spondylitis reported in the literature were examined roentgenologically in a late stage. Generally there has been a chronic spondylitis with a long interval since the onset of the primary disease.

Five roentgenograms.

J. P. CHAMPION, M.D.
Grand Rapids, Mich.

Primary Tumors of the Pelvic Bones: A Roentgen Diagnostic Study of Eighty-Three Cases. Carl Gustav Helander and Åke Lindbom. Acta radiol. Suppl. 152, 1957. (Roentgendiagnostic Department, Karolinska Sjukhuset, Stockholm, Sweden)

This excellent monograph is the result of a review of 83 cases of pelvic primary bone tumors collected from three radiotherapeutic centers of Sweden. All cases were studied with correlation of radiographs, histologic sections, and clinical history. Also considered are several cases of metastatic bone tumors and non-neoplastic lesions which are of interest from the point of view of localization.

The authors' tumor classification closely conforms to that of Lichtenstein. Chondromatous tumors, not subdivided into benign and malignant, since even the histological benign examples show "local malignancy," compose the largest single group. Giant-cell tumors, chordomas, Ewing's sarcoma, osteogenic sarcoma, fibrosarcoma, undifferentiated sarcoma, and angiomatous tumors were found in this decreasing order of frequency.

Each tumor type is discussed clearly, through briefly, in an easily readable style, with excellent positive reproductions of radiographs for each type. Short clinical histories and prognoses are included, but no effort is made to consider therapy. Non-neoplastic lesions and metastatic tumors are presented for their differential diagnostic interest, and aspects of various localizations in the pelvis are discussed.

This concise monograph is heartily recommended as a short, easily assimilable study.

Fifty-three roentgenograms; 1 photomicrograph; 4 diagrams; 2 tables. WENDELL BURNS, M.D.
The Henry Ford Hospital

GYNECOLOGY AND OBSTETRICS

Dose Reduction in Pelvimetry. A. Appleby, P. M. Hacking, and C. K. Warrick. Brit. J. Radiol. **31**: 267–271, May 1958. (Royal Victoria Infirmary, Newcastle upon Tyne, England)

For reducing the amount of radiation received by the fetus and the maternal pelvic organs in the course of pelvimetry, the authors use lead shields interposed between the x-ray tube and the patient and have found these to make a significant difference even with carefully coned-down exposures.

The tube is accurately centered to the appropriate point in each of the two projections commonly used. The lead shield is then put in place, the centering point being permanently marked on the shield to facilitate correct positioning. The shield for the anteroposterior view is in the form of a bridge 12 in. above the table top; that for the lateral projection is mounted on casters and is counterweighted and thus adjustable in height. The thickness of the lead is 2 mm. Although the field size is diminished, no increase in exposure has been found necessary. A photograph shows the patient standing before a Bucky diaphragm with the shield and tube in position for a lateral view.

Ionization-chamber measurements at different levels with cones of different size are recorded. The most striking feature of the paper is the graph demonstrating the reduction in exposure resulting from shielding.

Two roentgenograms; 1 photograph; 6 drawings; 2 tables. SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

THE GENITOURINARY SYSTEM

Patent Urachal Cyst. Eugene S. Felderman and Theodore R. Fetter. J. Urol. **79**: 767–770, April 1958. (Jefferson Medical College Hospital, Philadelphia, Penna.)

The urachus, vestigial remnant of the allantois, communicates in fetal life with the urinary bladder and extends into the umbilical cord at one period. Normally it atrophies completely, but rarely it persists and is recognized by virtue of causing a urinary fistula at the umbilicus or because of infection.

In the authors' case, quite by accident, a urachal cyst was discovered communicating with the bladder on cystograms done because of prostatic hypertrophy. The orifice could not be seen on cystoscopy even after its presence was known. Resection was done.

Four roentgenograms; 1 photomicrograph; 2 photographs. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

MISCELLANEOUS

A Review of Roentgen Findings in Systemic Lupus Erythematosus (SLE). David M. Gould and Marvin L. Daves. Am. J. M. Sc. **235**: 596–610, May 1958. (D. M. G., University of Arkansas Medical Center, Little Rock, Ark.)

The roentgen findings in systemic lupus erythematosus are individually ill defined and nonspecific, but collectively they form a well defined constellation of six "stars": pleuritis, pneumonitis, carditis, splenitis, enteritis, and arthritis. The incidence of their roentgen, clinical, and pathologic manifestations is as follows:

	Roentgen (per cent)	Clinical (per cent)	Pathologic (per cent)
Pleuritis	74	46	67
Pneumonitis	50	25	42
Carditis	53	56	55
Splenitis	34	21	95
Enteritis	20	31	26
Arthritis	26	88	..

Pleuritis: Roentgen studies show that the pleural reaction, often minimal and bilateral, varies from a subtle blunting of the costophrenic sulci to rather massive effusion. Necropsy reveals fibrinous pleuritis in 67 per cent of the cases. Delicate adhesions are present in subacute stages, and thickened adherent and fibrotic pleural surfaces are seen in chronic cases.

Pneumonitis: Lung involvement is usually described roentgenologically as consisting in patchy lesions resembling bronchopneumonia, atelectasis, infarction, and even gangrene. There may be an acute patch of pneumonitis, ill defined in both outline and substance, or a chronic horizontal atelectatic plaque. Both forms occur most frequently at the lung bases. The tendency toward bilateral involvement is less marked than with pleuritis. If the ill defined patch is followed over a period of time, it may change to a horizontal atelectatic plaque or band.

Carditis: Many cases of systemic lupus erythematosus show variation in the size and configuration of the heart. At times, the abruptness of change within a period of days is startling, but more often the variation in heart size takes place over a period of weeks and may even be overlooked until an early study is compared

with a later one. Definite evidence of myocarditis, pericarditis, or endocarditis is rare.

Splenitis: The size of the spleen can be estimated roentgenologically by measuring its length and width on a film of the left upper quadrant of the abdomen. Its medial border is outlined by the gas in the body and fundus of the stomach and in the splenic flexure of the colon. The lower tip of the spleen can be distinguished from the surrounding radiolucent fat. More accurate than the absolute size of the spleen is the observation of increasing size on serial films. Clinically the reports of splenomegaly have varied from 8 to 41 per cent.

Enteritis: Clinically impressive gastrointestinal and abdominal symptoms, sometimes mimicking the "acute surgical abdomen," often lead to barium and gastrointestinal roentgen studies, but the x-ray findings may be overlooked unless strict attention is paid to minutiae. They are similar to those found in scleroderma but much milder in degree. Barium studies generally reveal lack of tone, slight dilatation, and poor peristaltic activity, and, on occasion, a pattern identical with that of ulcerative colitis.

Arthritis: Because of arthralgia, patients with systemic lupus erythematosus have many examinations of various joints. Here again, a striking discrepancy exists between the roentgen pattern and the clinical history. The patient may have impressive symptoms and disabling, painful, hot, swollen joints. Early arthritis in this disease cannot be differentiated from early rheumatoid arthritis, and combinations of the two conditions do exist. As the years pass, however, the patient with systemic lupus erythematosus shows no real clinical or roentgen evidence of an advancing destructive arthritis.

Once the proper diagnosis has been established, it must not be forgotten that the lupus patient is prone to many complications, *e.g.*, tuberculosis, bacterial and fungous infections, amyloidosis, or even carcinoma. Such complications should not be passed off as another manifestation of systemic lupus erythematosus, particularly during steroid therapy.

Four roentgenograms; 1 drawing; 4 tables.

Pseudopneumoperitoneum. Simulated Free Air in the Peritoneal Cavity. John F. Mokrohisky. Am. J. Roentgenol. **79:** 293–300, February 1958. (St. Vincent's Hospital, Green Bay, Wis.)

In a review of the films of 600 patients, free air under the diaphragm was simulated 11 times. In 7 of these cases the appearance was the fortuitous result of a substantial fat pad under the left hemidiaphragm; in 4 the radiolucence was produced by irregularity or lobulation of the left leaf of the diaphragm. The constancy of the thin, long, semilunar radiolucent shadow under the diaphragm in various positions established the diagnosis of pseudopneumoperitoneum due to a subdiaphragmatic fat pad. Strangely, none of these patients were obese. In the cases of lobulation a lateral film and fluoroscopy established the true nature of the shadow.

While pseudopneumoperitoneum is of little importance in routine films, the problem in the "acute abdomen" is pressing. Consideration of this possibility along with the simple maneuvers noted above should lead to the correct diagnosis.

Thirteen roentgenograms; 2 drawings; 1 table.

SAUL SCHEFF, M.D.
Boston, Mass.

A Two-Year Experience of Teaching Medical Radiology in the Medical Institute. N. N. Mirolyubov. Med. radiol. **3:** 77–79, May-June 1958. (In Russian) (Irkutsk Medical Institute)

Since 1954 Russian medical institutes have been creating chairs in Medical Radiology (this term includes radiation therapy, radioisotopes, and the biological effects of radiation. It does not include diagnostic roentgenology). Thirty-six hours of instruction are given to medical students, twelve hours of lectures and twenty-four hours of practical demonstrations.

Radiation sickness and its treatment are demonstrated on guinea-pigs which receive 600 to 700 r. Blood smears, histological preparations and movies are also studied. The greater part of the course deals with radioactive isotopes for therapeutic and diagnostic purposes. Four hours are allotted to dosimetry, and methods of radiation therapy are demonstrated.

As the uses of ionizing radiation are penetrating into new medical areas, the author believes that the thirty-six hours devoted to the field, and the textbooks therefor, are inadequate. Every student should have the necessary equipment in order to enhance his knowledge of the subject.

B. ABRAMSON, M.D., AND F. RIEBEL, M.D.
Columbus, Ohio

TECHNIC

Supervoltage Roentgenography. Gerald M. McDonnel, Harry L. Berman, and Elmer A. Lodmell. Am. J. Roentgenol. **79:** 306–320, February 1958. (Walter Reed Army Hospital, Washington 12, D. C.)

For supervoltage roentgenography the authors used a 1,000-kvp resonant transformer with a focal spot of 1.2 cm. and a target-film distance of 56 inches (140 cm.). Occasionally a closed lead shutter was employed to shield the film during the build-up to 3 ma, but more often the build-up time was included in the exposure time, which was 6 to 8 mas for the chest; 15 mas for the nasopharynx; and 20 mas for the abdomen. The best films were produced by encasing Kodak No-Screen Film between a front lead screen of 0.005 in. and a back lead screen of 0.02 in., except for examinations of the head and neck, where increasing the thickness of the back screen offered no advantage. These lead screens replace the conventional intensifying screens. Back-scatter from the back screen must be in large part responsible for image production, since the image can be fogged when cardboard is interposed between the screen and the film. No such change is produced with cardboard behind the anterior lead screen.

Exposures to the patient measure less than 1 r for a chest film, 1.5 r for a roentgenogram of the head, and 2 r for an abdominal film. Development of the films is carried out in the routine manner.

It has been shown that differences in absorption of radiation by various tissues is gradually decreased as the kilovoltage rises, so that at around 1,000 kvp little difference exists on the film between bone, muscle, and fat, while the air-containing structures stand out clearly. Diagnostic usefulness at the higher kilovoltages is thus high around parts which normally contain or are surrounded by air or where air or gas may be introduced as a contrast substance.

The marked contrast between air-containing structures and solid tissues is particularly well demonstrated on the postero-anterior chest film, where the bony struc-

tures are only faintly visible but the upper respiratory tree is well outlined, as are the medial borders of the lungs superimposed on the heart shadow, their inferior margins below the domes of the diaphragm, and the junction of the mediastinal pleuras anterior to the aorta, forming an x-shaped shadow. The lateral chest exposure increases the total area of lucency by partially obliterating the spine and shoulders.

By subduing overlapping bone shadows, supervoltage technic enables one to visualize lung densities and subtle variations in aeration to bring into focus retrocardiac and infradiaphragmatic abnormalities in a qualitative manner. Displacement of lung margins may be of help in diagnosis. Eight cases are reported to indicate the value of the technic in finding small lesions, aortic abnormalities undemonstrated on routine study, and relatively minor alterations in the position and shape of the air-containing structures.

When inspection fails to resolve problematic lesions of the larynx, nasopharynx, and laryngopharynx, supervoltage roentgenography will serve to eliminate obscuring overlying shadows. Four cases are reported in this category.

The authors' experience with injected air for contrast is limited to a cervical myelogram and to a retroperitoneal pneumogram; in both, supervoltage technic was employed to good advantage.

Thirty-three roentgenograms.

SAUL SCHEFF, M.D.
Boston, Mass.

Carbon Dioxide as Contrast Medium in Roentgenography. William S. Blakemore, John J. Murphy, Henry P. Pendergrass, and R. R. Greening. J.A.M.A. **167:** 310–312, May 17, 1958. (W. S. B., University of Pennsylvania School of Medicine, Philadelphia 4, Penna.)

The authors have studied 15 patients over a few months time by perirenal carbon dioxide insufflation. In 3 patients adrenal tumors were satisfactorily demonstrated. Carbon dioxide is advantageous in that it involves much less risk of air embolism than oxygen or air. It has the disadvantage of more rapid absorption.

The authors abandoned presacral carbon dioxide insufflation of the retroperitoneal space after 4 attempts. Amounts between 900 and 1,500 c.c. were used, but absorption was so rapid that visualization was poor. They cite others who have obtained satisfactory results with larger amounts and/or more rapid injection.

Their perirenal technic is described. They inject from 250 to 300 c.c. of carbon dioxide via a No. 18 needle unilaterally, remove the needle, and obtain films in multiple projections within ten to twenty minutes. Simultaneous pyelograms may be made. If the suspected tumor is not seen, the opposite side may be insufflated by the same technic. Epigastric and/or shoulder pain is usually elicited when approximately 300 c.c. have been injected.

Two roentgenograms.

B. JAY HILL, M.D.
University of Michigan

Direct Color Roentgenography; The Theory and Facts of Color Roentgenography. Louis J. Bonann. Am. J. Roentgenol. **79:** 333–341, February 1958. (Department of Radiology, University of California School of Medicine, Los Angeles 24, Calif.)

This paper deals with the historical, factual, and theoretical considerations of direct color radiography. The earliest radiation dosimeters were based on the physicochemical effects of roentgen rays on colored compounds. This led to the development of the Hampson Radiometer, which is based on the color change of a small plaque of barium platinocyanide when irradiated. The author believes that the shortest path to the development of color radiography lies in taking advantage of the ionization caused by radiant energy to produce physicochemical changes in compounds which will color in proportion to the degree of absorption of energy; *i.e.*, the denser a structure on the film, the greater the absorption of energy, and the greater the change in color. This statement is, of course, a simplification of the goals the author has set up for himself. He discusses the basic physics of ionizing radiation, its effect on labile chemicals, and their resultant color change.

By adding chemicals or dyes to the raw film, or by introducing them during the processing, direct color radiography becomes possible. The author believes that the best and most direct method will have the color formers incorporated in the raw film. To date his materials have shown a tendency to deteriorate under the influence of time, temperature, moisture, light, and even inherent chemical fumes. He is continuing his work so that the visual acuity of the radiologist, limited at the present time by black and white films, will be enhanced.

Three photographs.

SAUL SCHEFF, M.D.
Boston, Mass.

Indirect Lymphography with Temporary Occlusion of the Blood Capillaries. P. Málek and J. Kolc. Acta radiol. **49:** 361–368, May 1958. (In German) (Institut für klinische und experimentelle Chirurgie, Prague, Czechoslovakia)

This is a preliminary report on a method of obtaining lymphograms by injecting a water-soluble iodine-containing contrast agent into an area rich in lymphatics, resorption of the contrast material being retarded by adrenalin, which temporarily contracts the blood capillaries. This simple method results in lymphograms comparable to those obtained with Thorotrast.

The authors have experimented widely with animals and have just begun with human material. Up to the time of their report they had used the method only in those patients in whom the part for examination was later to be extirpated surgically, such as a cancerous breast, because of the unknown effects of the contrast material remaining so long in the lymphatics.

Several illustrative lymphograms in dogs are presented, as well as one in a human cancer-containing breast with a normal lymphatic pattern, and another with a lymphatic pattern distorted by lymph node metastases.

Six roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Some Sources of Error in the Interpretation of Retropneumoperitoneum: Critical Considerations on Picture Origin and Application of Tomography. J. Franzen. Fortschr. a. d. Geb. d. Röntgenstrahlen **88:** 557–565, May 1958. (In German) (Johannes-Gutenberg-Universität, Mainz, Germany)

The introduction of air into the retroperitoneum permits radiographic and tomographic demonstration of

multiple structures—vessels, ureters, nerves, and fascia as well as the abdominal organs—which may complicate interpretation of the findings. The adrenals may occupy any position from the upper pole to the hilus of either kidney. Instead of the classical triangle or convex-triangular form they may assume various bizarre shapes. They may be in only loose relation to the kidneys and readily separable or again in intimate relationship and barely distinct but for a possible indentation of the adrenorenal contour. They are most readily identified by demonstration of the adrenophrenic ligament.

Failure of radiographic demonstration of the adrenals is not necessarily consistent with the diagnosis of aplasia. On the other hand, a normal radiographic appearance does not exclude a parenchymal adrenal tumor.

Adrenal tumors can be simulated by the tail of the pancreas, an accessory spleen, a lobulated spleen, or composite shadows of these structures.

Seven roentgenograms; 9 diagrams.

G. A. DOEHNER, M.D.
St. Vincent's Hospital, New York

"Spot" Photofluorography with Image Intensifier and New Polaroid Projection Film: Application Foreshadowing Immediate Reporting and Miniaturization, Duplication and Projection of Roentgen Film Records with Reduction in Radiation Exposure. Herbert M. Stauffer, Archie W. Blackstone, and Edward E. Christensen. Am. J. Roentgenol. **79:** 888–890, May 1958. (Temple University School of Medicine and Hospital, Philadelphia 40, Penna.)

The authors adapted the Polaroid camera back to the Phillips image intensifier. The output phosphor of a Phillips electronic image intensifier was photographed on the new Polaroid-Land projection film (Type 46–L), which has a speed (ASA exposure index equivalent) of 1,000 daylight and 700 tungsten. The standard Polaroid paper material proved to be too slow for practical use. With an 8-inch lens, an image 2 inches in diameter is obtained, which is approximately four times the diameter of the Phillips intensifier output phosphor and about one-half the diameter of the original input image. By photographing the intensifier phosphor with a lens of 4 inch focal length, an image approximately 1 inch in diameter is obtained and by serial shifting of the position of the camera back relative to the lens it is possible to obtain up to 6 spot photofluorograms on one $3^1/_4$ by 4-inch Polaroid film frame. Such small images can be viewed directly in a simple magnifying viewer or by projection; photographic enlargements may be used as clinical film records. The Polaroid film frame can be immediately processed and viewed within two minutes from the time of the last exposure.

Four roentgenograms; 2 photographs

ALFRED O. MILLER, M.D.
Louisville, Ky.

RADIOTHERAPY

Malignant Argentaffinoma and the Carcinoid Syndrome. Dennis M. Krikler, Henriette Lackner, and Rossall Sealy. South African M. J. **32:** 514–520, May 17, 1958. (Groote Schuur Hospital, Cape Town, Union of South Africa)

The term "carcinoid syndrome" has been suggested to describe those cases where metastasizing argentaffinoma gives rise to systemic manifestations. These consist of vasomotor disturbances (flushing and a peculiar cyanosis), increased bowel motility (diarrhea and borborygmi), bronchial constriction ("asthma"), cardiac disturbances (pulmonary stenosis and tricuspid stenosis and incompetence, leading to heart failure) and, less frequently, pellagra. These tumors secrete 5-hydroxytryptamine (5-HT, serotonin, enteramine), which is commonly thought to produce the systemic effects.

Although carcinoids are most frequently found in the appendix, metastases from that site are rare, and this report is confined to extra-appendiceal cases. The second commonest site is the ileum, but the tumors may occur anywhere in the gastrointestinal tract. Bronchial adenomas of "carcinoid type" have also been found to be sources of functioning metastases.

Since metastases appear to be an integral part of the syndrome, the ultimate prognosis is invariably poor. On the other hand, the tumor and its metastases often grow very slowly and cases are recorded with a lapse of more than thirty years between the appearance of the gastrointestinal symptoms and the establishment of the diagnosis.

The authors report 11 cases. In 3, the primary tumor was in the ileum; in 3, in the cecum; in 1 each in the bronchi, rectum, and duodenum. In 2 cases the primary site was not known.

The common situations of metastases are regional lymph nodes, liver, and ovaries. Bony metastases are unusual but have been reported. Radiologically the earliest feature of bone secondaries is ill defined sclerosis accompanied by aching pain, which is followed by more definite sclerosis and bony expansion.

Resection of the primary and secondary growths offers the only chance for cure. Manipulation of large growths during their removal may precipitate severe symptoms of excess of 5-HT; preoperative irradiation may prevent this. Deep x-ray therapy seems to "damp down" both local and systemic effects of carcinoid metastases; in 1 case small doses produced prompt relief of bone pain. Reasonable dosage appeared to be about 3,000 r (incidence dose) over a period of ten days for bony deposits; 2,750 to 3,000 r tumor dose over four to five weeks for hepatic metastases, and 3,000 to 3,500 r tumor dose over four weeks for pulmonary lesions. Radioactive colloidal gold is largely concentrated in the liver and should be useful for hepatic metastases. Temporary improvement has been reported after its intravenous administration, but the results seem inferior to those of deep x-ray therapy.

Six roentgenograms; 2 tables.

ALFRED O. MILLER, M.D.
Louisville, Ky.

RADIOISOTOPES

Observations on the in vivo Distribution of Radioiodine in Thyroid Disease. N. Kalant, D. L. Wilansky, and J. Wolfson. Canad. M. A. J. **78:** 668–671, May 1, 1958. (Jewish General Hospital, Montreal, Que., Canada)

The authors have attempted to assess the status of neck scanning as an investigative tool in thyroid disorders. While more experience is required before its final role is established, it is a procedure of considerable promise. The most serious limitation of the method is its lack of depth discrimination. In selected patients, particularly those with large goiters, this difficulty may be overcome by making both lateral and frontal scans. The technic has been useful in the differential diagnosis of mediastinal masses, in demonstrating that any known metastatic lesion is of thyroid origin, and, to a limited extent, in the detection of relatively uncommon carcinomatous nodules. Most thyroid carcinomas pick up little or no radioiodine, but this same lack of activity may also be observed in adenomas, cysts, and organized hematomas.

Since functional carcinomas are sometimes amenable to radioiodine therapy, scanning is important in determining the feasibility of this form of treatment. It does not play a major role in the clinical assessment of a hyperthyroid patient; its main use there is as a tool for clinical research into the mechanisms of hyperthyroidism. It may prove to be of value in guiding the surgeon in the performance of subtotal thyroidectomy so that postoperative complications may be reduced.

Six cases are reported, illustrating respectively, a solid thyroid carcinoma, a calcified adenoma, a nodule which at first appeared hyperfunctional but was shown by a lateral scan to be hypofunctional, a mediastinal thyroid, metastatic thyroid carcinoma, and a hyperfunctioning multinodular goiter.

Variance of Measurement of Thyroid Uptake of Radioiodine Due to Compton Effect. Egilda DeAmicis and Russell F. Cowing. J.A.M.A. **167:** 314–315, May 17, 1958. (R. F. C., 194 Pilgrim Road, Boston 15, Mass.)

A comparison was previously made of a single scintillation counter technic and a four Geiger-Mueller (bismuth cathode) tube set-up in measuring the twenty-four-hour I^{131} uptake in the thyroid gland (DeAmicis and Williamson: J.A.M.A. **161:** 1377, 1956. Abst. in Radiology **68:** 911, 1957). These were found by statistical analysis to give the same results. The technic of measurement with each method is described.

After a modification of the scintillation counter by the manufacturer, comparison of the two set-ups revealed the scintillation measurement to be 20 to 25 per cent higher. Later this scintillation counter was repaired and after repair it was found necessary to regulate the sensitivity by adjusting the pulse-height control. With this new setting the scintillation counter readings without lead and with 0.43, 0.86, and 1.1 mm. of lead were essentially the same as with the four-tube Geiger-Mueller tube set-up.

Evaluation of possible scattering from the patient (Compton effect) was done between the manufacturer's modification and later repair and adjustment. For this purpose various thicknesses of lead were attached to the face of the counter. These studies demonstrated that soft scatter from the patient is not completely eliminated and varies with individual patients No relationship of the scatter factor to neck size, weight, or age, could be found.

The authors conclude that with use of scintillation equipment in I^{131} uptake studies by the thyroid, it is advisable to check the possible effect of scatter, and one way of doing this is with various lead filters.

One table.

B. JAY HILL, M.D.
University of Michigan

Roentgen Contrast Media and the Radioiodine Test of the Thyroid Gland. R. Schüssler. Fortschr. a. d. Geb. d. Röntgenstrahlen **88:** 579–584, May 1958. (In German) (Universität des Saarlandes, Homburg, Germany)

Experiments on 15 white rats with a cholangiographic medium—Radioselectan Biliaire—containing iodine in organic linkage confirmed the observations of others that administration of an iodized contrast medium depresses the uptake of I^{131} by the thyroid. A similar result was obtained with Biligrafin. The disturbance was found to be maximum on the third day following the administration of the medium. After fifty days the uptake was slightly elevated.

Two figures; 2 tables.

G. A. DOEHNER, M.D.
St. Vincent's Hospital, New York

Biologic Half-Life of I^{131} in the Thyroid of Healthy Males. Gilbert Rosenberg. J. Clin. Endocrinol. **18:** 516–521, May 1958. (Ste. Anne's Hospital, Ste. Anne de Bellevue, Que., Canada)

In a study of 38 normal male subjects from twenty-two to eighty-three years of age it was found that in those under fifty there was no correlation between biologic half-life of I^{131} and the twenty-four-hour uptake or the age of the patient. Among those over fifty (26 patients), the biologic half-life tended to increase directly with age, while at the same time it bore an inverse relationship to the twenty-four-hour uptake, so that as the uptake increased the biologic half-life diminished. The author suggests that variation in the re-accumulation of I^{131} may explain this difference between the two groups. This supposition was not explored, however.

In general, the twenty-four-hour uptake seems to diminish somewhat with age, though the protein-bound iodine shows no significant change. It is presumed that in the older group there is diminished secretion of thyroid hormone coupled with a decreased peripheral utilization, thus accounting for the unchanged PBI.

Three graphs; 1 table.

G. MELVIN STEVENS, M.D.
Palo Alto, Calif.

Enhanced Urinary Excretion of Co^{60} Vitamin B_{12} Produced by Delayed Release Capsules. P. C. Johnson and E. S. Berger. Blood **13:** 457–463, May 1958. (VA Hospital, Oklahoma City, Okla.)

Co^{60}-labeled vitamin B_{12} was utilized in aqueous solution and in delayed release capsules to study the effect of the rate of release of the vitamin on its absorption.

Fecal excretion seemed to be unaffected by the rate of release. At the same time, 24-hour urinary excretion was significantly increased from a mean value of 3.7 per cent among the controls (those receiving the aqueous

solution) to 7.1 per cent among those given seven-hour release capsules. A possible explanation is that the absorbed vitamin B_{12} is bound to the serum proteins more efficiently in the delayed release groups.

Five tables. G. MELVIN STEVENS, M.D.
Palo Alto, Calif.

The Radio-Iodinated Triolein Test for Steatorrhea. Morton I. Grossman and Paul H. Jordan, Jr. Gastroenterology **34:** 892–900, May 1958. (VA Center, Los Angeles, Calif.

A comparison was made of the blood and fecal radioactivity and fecal total lipid in 26 control subjects and 23 patients with chronic pancreatitis following administration of a test dose of radio-iodinated triolein. Nine of the patients with pancreatitis did not manifest steatorrhea as judged by either chemical analysis of feces for total lipid or radioactivity of blood or feces. Of the 14 patients with steatorrhea, all had an abnormally high fecal excretion of radioactivity, but only 4 had diagnostically low levels of blood radioactivity. In the 10 patients whose blood values were in the normal range, the mean values were significantly lower than the corresponding values for the control group. None was sufficiently low for diagnosis, but as a group the patients could be distinguished from normal subjects. The authors conclude that, "as the test is currently performed by us and by others, the finding of a normal blood level of radioactivity does not exclude the existence of steatorrhea."

Five tables. RICHARD A. ELMER, M.D.
Atlanta, Ga.

Intestinal Absorption of Iodine^{131}-Labeled Triolein and Oleic Acid in Normal Subjects and in Steatorrhea. Ervin Kaplan, Bernard D. Edidin, Robert C. Frvin, and Lyle A. Baker. Gastroenterology **34:** 901–909, May 1958. (VA Hospital, Hines, Ill.)

Observations were made of the blood levels of radioactivity after ingestion of I^{131}-labeled oleic acid and I^{131}-labeled triolein by 11 and 33 male hospital patients, respectively. These patients did not have steatorrhea or other gastrointestinal complaints. Five patients with steatorrhea were similarly studied.

The findings indicate that the blood level of activity after ingestion of either I^{131}-labeled triolein or oleic acid, by the normal human male, is confined within a narrow and characteristic range. The levels observed with triolein at four hours average 2.14 per cent, with a range of 2.15 per cent.

Following ingestion of labeled triolein and oleic acid by patients exhibiting a digestive defect (such as chronic pancreatitis), oleic acid levels were normal but triolein was reduced. In a single patient with an absorptive defect (sprue), the blood level of radioactivity following ingestion of labeled triolein and oleic acid indicated subnormal levels of both preparations.

The authors conclude that "the absorption of triolein and oleic acid in digestive and absorptive defects with steatorrhea would appear characteristic enough to differentiate these defects from the normal and from each other."

[It should be pointed out that the number of abnormal cases tested in this series is very small, particularly of the absorptive defects (a single case of sprue). Grossman and Jordan (see preceding abstract) stated that a normal blood level of radioactivity, as determined by the labeled-triolein test, does not exclude the existence of steatorrhea.—R.A.E.]

Six graphs; 2 tables. RICHARD A. ELMER, M.D.
Atlanta, Ga.

Effect of Estrogen on Iodinated Amino Acids of the Thyroid and Serum. Joseph D. Feldman. Am. J. Physiol. **191:** 301–305, November 1957. (University of Pittsburgh School of Medicine, Pittsburgh, Penna.)

A chromatographic analysis of hydrolyzed and nonhydrolyzed thyroid tissue and of serum was made six and twenty-four hours after the administration of I^{131} to estrogen-treated and control castrate male rats. No consistent significant differences were noted between the thyroids and sera of experimental and control animals. Triiodothyronine was released more rapidly from the thyroids of all animals than was thyroxine. Thyroidal accumulation and renal excretion of I^{131} was also studied. When 10,000 IU of estrogen (1.0 mg. estrone) were administered over four days, twenty-four-hour renal excretion of I^{131} was significantly depressed. When 1,000 IU of estrogen (0.1 mg. estrone) were administered over four days, twenty-four hour renal excretion of I^{131} was depressed to a lesser degree. It was concluded that the action of estrogen on thyroidal uptake was twofold: indirect, by suppression of I^{131} urinary excretion, and, most likely direct, from the evidence cited, by enhancing the iodide-trapping mechanism.

Two tables. AUTHOR'S ABSTRACT

The Use of Gold and Silver-Coated Radioactive Gold Colloids in the Palliation of Ascites and Pleural Effusions. P. F. Hahn, G. R. Meneely, and E. L. Carothers. Brit. J. Radiol. **31:** 240–245, May 1958. (Meharry Medical College, Nashville, Tenn.)

The authors briefly review the previous literature on the control of ascites and pleural effusions by the use of radioactive gold. They estimate that 80 per cent of the production of radioactive gold at Oak Ridge (20 c per week) and approximately an equal amount at Harwell are now directed toward such palliative therapy. This amount is sufficient to treat approximately 10,000 patients per year.

It had previously been found that radioactive gold colloids were very slowly transported from the alveoli of the lungs to the regional lymph nodes (Meneely et al.: Am. J. M. Sc. **225:** 172, 1953. Abst. in Radiology **61:** 984, 1953). Silver colloids, on the other hand, were rapidly carried from the lungs to the mediastinal, bronchial, and hilar nodes (Hahn et al.: J. Lab. & Clin. Med. **39:** 624, 1952. Abst. in Radiology **60:** 325, 1953). Ag^{111}, however, is neither conveniently nor economically produced in the chain-reacting pile, and for this reason the use of silver colloids dispersed in the presence of radioactive gold colloids as nuclei was devised by Hahn and Carothers in 1953 (J. Thoracic Surg. **25:** 265, 1953. Abst. in Radiology **62:** 155, 1954).

In 119 treatments given to 106 patients, control of effusions or ascites was attempted by the use of both types of colloids. While the numbers of cases are not statistically significant, the greater effectiveness of gold alone appears to be demonstrated in the abdomen (80 per cent as compared to 62 per cent for gold and silver). In the pleural sac 70 per cent effectiveness was noted with gold and 100 per cent with silver and gold.

The authors based their studies on a method of in-

troduction of the material which is very simple—a multiple syringe technic, where the speed of injection is the determining factor in the protective aspects of handling the material. The results are assayed on an objective basis in an attempt to demonstrate palliation even though follow-up in some instances was rather short. In one case, in six weeks of tapping the thorax, a total of 10,450 ml of liquid was removed. Following the introduction of 72 mc of Au^{198} a single tap in a period of four and a half weeks yielded only 1,000 ml.

It is stated that the average dose per treatment at first ran from 100 to 125 mc for intraperitoneal therapy and this at the present time has jumped to 150 mc. Originally 75 mc were used on one side of the pleural space; this has increased to 100 or 125 mc as familiarity with the technic has allowed better evaluation and safer handling of the materials.

Two tables.

SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

Use of Radioactive Phosphorus in the Therapy of Leukemia, Polycythemia Vera and Lymphomas: A Report of 10 Years' Experience. Robert B. Chodos and Joseph F. Ross. Ann. Int. Med. **48:** 956–977, May 1958. (VA Hospital, Syracuse 10, N. Y.)

The authors summarize ten years of experience with radioactive phosphorus in the clinical management of patients with leukemia, lymphoma, and polycythemia vera. The isotope was given only when there was evidence of progression of the disease. Seventy-one patients were treated from April 1944, when the initial course was administered, to April 1954.

The diagnosis of leukemia and myeloma was based upon a study of the peripheral blood, sternal marrow, and the clinical manifestations. The diagnosis of Hodgkin's disease was made by lymph-node biopsy. Lymph-node and skin biopsies were both utilized to establish the diagnosis of mycosis fungoides. The criteria for diagnosis of polycythemia vera were a significant elevation of the red cell count, hemoglobin, and hematocrit, usually with coexisting elevation of the white cell and platelet counts. Clinical observations and hematologic studies were repeated at approximately one-month intervals.

The radioactive phosphorus was administered intravenously as an aqueous solution of sodium phosphate.

Chronic Granulocytic Leukemia: Thirty patients with chronic granulocytic leukemia (18 females and 12 males) were treated with radioactive phosphorus. Only 5 were alive at the termination date of this study, having survived 15, 16, 22, 28.5 and 64 months since diagnosis was established. The median survival since diagnosis was 20 months; since the onset of symptoms, 27.6 months.

The initial course of radiophosphorus varied from a single intravenous injection of 3 to 14 mc to a total of 20 mc administered in doses of 0.85 to 9.8 mc at four- to ten-day intervals during a period of up to seven weeks. In response to this therapy, 27 of the 30 patients showed a marked decrease in white blood cell count.

X-ray therapy to the spleen or spray radiation was administered when P^{32} failed to control the disease. These treatments frequently produced a decrease in the white blood count and splenomegaly.

Chronic Lymphocytic Leukemia: Twelve patients with chronic lymphocytic leukemia received radioactive phosphorus. These patients ranged in age from 41 to 78, with a mean age of 62.4 years. Eleven had died by the termination date of this report. The mean survival of the entire group was 34.3 months since diagnosis, and 51 months since the presumed onset of the disease.

The initial course of radiophosphorus in this group ranged from 3 to 13.4 mc. In general, individual doses of 1 to 2 mc were used, although 5 or 6 mc were administered occasionally. This initial course usually extended over a period of from one to fifteen days. Therapy covered a period of four weeks in one patient, two months in another, and six months in a third.

Ten of the 12 patients responded to the initial course of P^{32}. The white blood count decreased in all 12 patients. Eleven showed a maximal response in from 3.5 to 10 weeks. One patient who received fractional therapy over a 6-month period did not respond maximally until 10.5 months after the initial dose. Leukopenia developed in 2 patients.

In general, the level of hemoglobin concentration reflected the extent of control of the disease.

In summary, radiophosphorus was of significant benefit in 5 patients, of limited benefit in 3, of transient benefit in 2, and of no benefit in 2.

Polycythemia Vera: Seven patients with polycythemia vera received P^{32} therapy. The survival of these patients ranged from 34 to 88 months after diagnosis, with a mean of 69 months. Therapy during this period included venesection, phenylhydrazine, roentgen irradiation, and radiophosphorus. Three patients had died and 4 were still alive at the end of the study.

Radiophosphorus was administered to patients with polycythemia vera in doses ranging from 1 to 5 mc. The initial course varied from a single dose of 4 mc to a total dose of 14.2 mc, given during a period of four and one-half months.

The polycythemic process was controlled for one to five years. A terminal leukemia developed in 1 patient and a refractory anemia in a second. Leukopenia occurred in 3 patients and a mild thrombocytopenia in 4. Hemorrhagic and thrombotic complications were infrequent and mild.

Multiple Myeloma: Seven patients with multiple myeloma who were treated with radiophosphorus survived from 6 to 38 months after diagnosis. Radiophosphorus was administered in small doses, usually 2 to 2.5 mc. The total initial course ranged from 1.60 to 12.8 mc, given over a period of from two days to three months. In general, radioactive phosphorus was not an effective therapeutic agent in this disease.

Hodgkin's Disease: Four patients with Hodgkin's disease were treated with radioactive phosphorus. Roentgen irradiation had previously controlled the disease for periods ranging from two to seven years. The beneficial effects of isotope therapy were limited and transient. Lymphadenopathy decreased in 3 patients. Hepatomegaly and splenomegaly diminished in 1.

Acute Leukemia, Chronic Monocytic Leukemia, and Mycosis Fungoides: Radiophosphorus was administered to 8 patients with acute leukemia without any significant therapeutic response. Four patients survived only eleven to twenty-eight days.

Two patients with mycosis fungoides received radioactive phosphorus. The beneficial effects consisted of slight, transient relief of pruritus, with only minimal objective improvement of the skin lesions.

Radioactive phosphorus did not significantly prolong survival of patients with either chronic granulocytic or lymphocytic leukemia.

Leukopenia, thrombocytopenia, and perhaps acute blastic leukemia may occur after P^{32} treatment of the chronic leukemias, particularly the granulocytic forms.

Seven diagrams; 7 tables.

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Incorporation of P^{32} in the Muscle by Normal and Thyrotoxic Resting Rats. Philip C. Johnson, Audrey F. Posey, Daniel R. Patrick, and Ranwel Caputto. Am. J. Physiol. 192: 279–282, February 1958. (School of Medicine, University of Oklahoma, Oklahoma City, Okla.)

The muscles of thyrotoxic and normal rats were compared in respect to their abilities to incorporate P^{32}, injected intravenously, into their organic compounds. When the overall incorporation was compared by determining the ratio of the specific activity of the organic phosphate of the muscle to the specific activity of inorganic phosphate of the blood, it was found that the process was faster in the thyrotoxic than in the normal animal. The data suggest that this results from faster penetration of inorganic phosphate into the cells of the thyrotoxic muscle. The incorporation of intracellular inorganic phosphate into organic phosphate appears, however, to be slower in the thyrotoxic animals. The ratio of the P^{32} incorporated into the organic components to the O_2 consumed (somnolent metabolic rate) was lower in the thyrotoxic rats.

The Use of Radioactive Chromium (^{51}Cr) in Clinical Medicine. Hal Crawford and G. C. de Gruchy. M. J. Australia 1: 657–662, May 17, 1958. (St. Vincent's Hospital, Melbourne, Australia)

The radioactive chromium technic for the estimation of blood volume and red cell life span is described. When this procedure is employed, transfusion is not required, only small amounts of blood are necessary, survival of the patient's cells can be followed in his own circulation, and the method can be used with all blood groups. It is of particular value in the estimation of red cell life span in patients with little or no anemia who, therefore, do not require transfusion. For all these reasons, the Cr^{51} technic is now the one of choice for determining red-cell life span in clinical practice.

The application of this method in clinical medicine is discussed, with particular reference to the use of blood volume determinations in the differentiation between true polycythemia and that of stress. The hematological and blood-volume studies in 3 cases of polycythemia of stress and in 8 of polycythemia vera are presented. In 2 of the former, a diagnosis of polycythemia vera had been made and the patients referred for treatment with radioactive phosphorus.

In the 8 cases of polycythemia vera, no treatment had been given in 5, and the diagnosis was clear because of the clinical and hematological features present. An additional patient was in clinical remission after P^{32} therapy. In the last 2 cases the polycythemia was masked by an increased plasma volume; one of these was untreated, with peripheral blood red cell values at the upper limit of normal; blood volume studies showed that the red cell volume was significantly increased, and the diagnosis of true polycythemia was established. In the other of these last 2 patients, in remission after P^{32} therapy, congestive cardiac failure developed; examination of the peripheral blood revealed an iron deficiency anemia, but blood volume studies showed a significant increase in red cell volume and a marked increase in plasma volume.

In addition to its main use for the determination of blood volume and red-cell survival, the labeling of red cells with Cr^{51} has recently been employed to determine the *in vivo* sites of red cell destruction, in the prediction of probable response to splenectomy in certain hemolytic anemias, as a method for the quantitative determination of bleeding into the alimentary tract, and for the labeling of leukocytes and of platelets.

Three figures; 3 tables.

Absorption of Radioiron Perfused Through the Duodenum of the Rat. Alvin S. Hyde. Am. J. Physiol. 191: 265–270, November 1957. (Tulane University School of Medicine, New Orleans, La.)

Retention and postabsorptive distribution of iron were studied by perfusing the small intestine of the rat at a constant rate with radioiron-ascorbate in a medium of known and constant composition in the absence of bile and pancreatic secretions. The intestine accumulated radioiron as long as perfusion was maintained (125 min.). The amount of iron retained varied considerably, from 3.79 to 9.35 μg., but the percentage distribution of the retained iron followed a consistent pattern during eighteen hours subsequent to perfusion. The amount retained was related to both length of time that the intestine was exposed to perfused iron and weight of the intestinal segment. Increasing the amount of iron-binding globulin in blood to three times the normal level by intravenous injection of iron-free siderophilin decreased the amount of iron accumulating in intestine and increased the rate at which iron entered blood. The total amount of retained iron increased to 1.5 times the mean retention of control animals. The increased retention was accounted for primarily by the enlarged iron-carrying capacity of the blood.

Three graphs; 1 table. AUTHOR'S ABSTRACT

Healing Bone Fractures and Simultaneous Administration of Radioisotopes of Sulfur, Calcium and Yttrium. N. S. MacDonald, P. C. Lorick, and L. I. Petriello. Am. J. Physiol. 191: 185–188, October 1957. (School of Medicine, University of California, Los Angeles, Calif.)

A mixture of carrier-free radioisotopes, Ca^{45}, S^{35}, and Y^{91}, was injected into rats bearing left tibial fractures, in states of repair varying from three to eighteen days. Twenty-four hours after injection, both tibias were removed and analyzed for content of each radioisotope. At all intervals up to eighteen days postfracture, the injured bone contained more of all three isotopes than the intact contralateral mate. A maximum in twenty-four-hour retention of radiosulfate in tissue at the fracture site was reached by the seventh to tenth day, after which retention of a dose of S^{35} declined rapidly. Retentions of a dose of Ca^{45} in the fractured bone also rose rapidly during the first three to ten days of healing. Thereafter, twenty-four-hour retention values continued to rise but at a reduced pace. The avidity of healing bone for yttrium increased sharply during the same three-to-ten-day interval during which radiosulfate deposition became most effective. After this time twenty-four-hour retention values for Y^{91} increased only slightly, if at all. The data suggest that formation of the sulfated mucopolysaccharides of osteoid matrix and fibrocartilaginous callus began by at least the third day, if not earlier. The healing fracture made its

greatest demand for plasma sulfate during the seventh to tenth day, postfracture. New calcium was laid down at the fracture site just as early as new sulfate, but the demands for plasma calcium continued throughout the eighteen days of observation, as might be expected for a mineralizing callus. Yttrium fixation in the healing bone appeared to be more closely related to events leading to organic matrix formation than to mineralization of the new tissue. AUTHORS' ABSTRACT

Hepatic Glycogen, Lipogenesis and Glucose-6-Phosphatase in X-Irradiated and Control Rats. John G. Coniglio, John C. Kirschman, and Granville W. Hudson. Am. J. Physiol. **191:** 350–354, November 1957. (Vanderbilt University School of Medicine, Nashville, Tenn.)

Incorporation of C^{14}-acetate into hepatic fatty acids increased in irradiated fasted rats (750 r total-body x-irradiation), compared to fasted controls, as early as six hours postirradiation. At this time hepatic glycogen in irradiated animals was lower than in controls and lower than in irradiated animals at thirty minutes postirradiation. Incorporation remained constant at twelve hours postirradiation but glycogen concentration in irradiated rats was increased over controls. At eighteen hours the irradiated rat exhibited both increased hepatic glycogen and increased lipogenesis. The increase in liver glycogen in irradiated fasted rats could be prevented effectively by administration of S, β aminoethylisothiouronium bromide ten minutes prior to irradiation. In those irradiated rats in which symptoms of toxicity of the drug were not severe, enhancement of hepatic lipogenesis either was not prevented or was only partly prevented. The results are consistent with the hypothesis that liver glycogen is not the sole factor contributing to increased hepatic lipogenesis in irradiated fasted rats. Assay for hepatic glucose-6-phosphatase at one-half, twenty-four and forty-eight hours after 750 or 1,000 r total-body x-irradiation revealed no significant change due to the irradiation. However, both concentration and total activity of the enzyme were increased by fasting.

Five tables. AUTHORS' ABSTRACT

The Effect upon the Hypophysis of Radioactive Yttrium. William A. Kelly, Joseph P. Evans, Paul V. Harper, and Eleanor M. Humphreys. Surg., Gynec. & Obst. **106:** 600–604, May 1958. (Argonne Cancer Research Hospital, Chicago, Ill.)

Hypophysectomy is believed to be of possible benefit in the treatment of metastatic cancer. The present article deals with an effort to destroy the pituitary gland by the instillation of radioactive yttrium pellets into the hypophysis. The work was conducted at the Division of Neurological Surgery, the Argonne Cancer Research Hospital and the Department of Pathology, University of Chicago. Twelve millicuries of Y^{90} divided among 16 sources are used at the present time to produce a coalescent necrosis.

Histologic studies of 19 pituitary specimens obtained at autopsy from an operative series of 43 cases which were irradiated with varying quantities of isotopes were available for study. The multiple pellet technic was found to produce a coalescent necrosis with a sharp border. Tissue peripheral to the border showed shrunken and deformed cells, the functional status of which remains to be determined.

In none of the 19 autopsy specimens available, was 100 per cent destruction of the gland observed. Despite this, many of the patients showed evidence of reduced pituitary function. Four of the 43 cases showed good evidence of healing of metastatic lesions and 4 more showed evidence of stabilized metastases.

Five photomicrographs; 1 drawing.

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RADIATION EFFECTS

An Examination of the Clinical and Experimental Data Relating to the Possible Hazard to the Individual of Small Doses of Radiation. L. F. Lamerton. Brit. J. Radiol. **31:** 229–239, May 1958. (Royal Cancer Hospital, London, S.W. 3, England)

The author clearly spells out the difference between the genetic and somatic effects of radiation, subdividing the latter into short-term and long-term effects. Among the severe late changes incident to irradiation are tumor induction and leukemia. The tumors, apart from leukemia, are classified as follows: (*a*) tumors arising in various tissues following radiotherapeutic procedures, mainly tumors of the skin and bone in adults and thyroid carcinoma in children; (*b*) skin tumors in radiation workers; (*c*) bone tumors in radium workers; (*d*) lung tumors in uranium miners. Leukemia has been observed in (*a*) radiologists and radiation workers; (*b*) survivors of atomic bombing in Japan; (*c*) patients receiving radiotherapy, particularly for ankylosing spondylitis; (*d*) children whose mothers had abdominal diagnostic examinations during pregnancy. Each of these categories is considered with liberal reference to the literature.

It is pointed out that the radiotherapeutic dosages responsible for tumors in adults have been high, and the same is probably true of occupational exposures, particularly in the case of the earlier radiologists. Bone tumors have arisen in persons in whom the terminal body burden of radium is a few micrograms, the lowest level to date for pure radium, unadulterated by mesothorium, being 3.5 micrograms. If uniformly distributed in the skeleton, this amount would produce a dosage rate of 3 rads per week to the bone, but radioautographic studies have indicated a very uneven distribution, so that some areas must of necessity be exposed to much larger doses.

It has been estimated that the uranium miners of Schneeberg and Joachimsthal may have received several thousands of rads of alpha rays to certain parts of the lungs over a working lifetime.

Under the heading Comparative Data for Children and Adults, attention is called to the much higher incidence of thyroid carcinoma in the younger group following irradiation of the lower neck and mediastinum.

For the bone-seeking isotopes, distribution is probably more important than actual dosage. Thus a dose of radioactive strontium or calcium of less than 2,000 to 3,000 rads is not significant for tumor production, whereas with plutonium the tumor incidence is greater than normal with a mean radiation dose of only 120 rads. Most of the bone-seeking radioactive material which is administered is deposited in the epiphyseal

region of the long bones and produces in the order of tens of thousands of rads. This characteristically leads to late changes, with the production of abnormal bone, and there is some evidence that tumors may arise at such sites.

In relation to leukemia, the question of chronic irradiation as contrasted to single exposures is considered. It has been found that single doses or doses divided into a few fractions are more efficient, dose for dose, in leukemia production in mice than long continued irradiation. The work of Court-Brown and Doll on leukemia following irradiation for ankylosing spondylitis is discussed at length (M. R. C. Reports. H. M. Stationery Office, London, 1956 and 1957). Of their conclusions the author says: "I do not wish in any way to underrate the excellence of this work but I think it is very important to realize that, although the results are not inconsistent with a linear and a non-threshold relationship between leukemia and radiation dose, neither do the data allow one to exclude a non-linear relationship with or without threshold."

The following excerpts from a section headed Theoretical Considerations are worth quoting: "For tumours of bone and in the skin there is some evidence that gross tissue damage is a necessary prelude to tumour formation, which would imply a substantial threshold dose. For other types of tumour it is difficult to come to even a tentative conclusion. From the experimental animal data there is some evidence that small doses of whole-body radiation can increase the incidence of certain tumours but the effects are very species-dependent and are possibly closely related to endocrine or other systemic disturbances. In spite of the lack of direct evidence one frequently encounters in the literature the categorical statement that there is a finite chance of producing these serious late effects with any dose of radiation, however small. The assumptions being made here are that malignancy arises as a result of a direct radiation effect on a cell causing it to change into a malignant cell, that there is a finite chance of such a change occurring however small the dose of radiation, and that a tumor can develop from a single mutant cell. Such a theory, however, does not necessarily follow from the fact of radiation-induced malignancy. There are possible mechanisms, such as selection of cells or changes produced in cells, not as a direct result of radiation, but as a result of disturbed environment or of abnormal repair processes. Indeed, the choice between these various mechanisms is a basic problem not only of radiation carcinogenesis but of carcinogenesis in general."

The author touches on the reduction in life span as a radiation effect, pointing out that the effects of diagnostic examination in this respect need not be considered at the present time, in view of the lack of substantial evidence, direct or circumstantial.

Two figures. SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

A Survey of Shoe-Fitting X-ray Fluoroscopes Located in New South Wales. Alan Bell and H. M. White. M. J. Australia **1**: 729–737, May 31, 1958. (Division of Industrial Hygiene, Department of Public Health, New South Wales, Australia)

A survey of 31 fluoroscopes in 14 shoe stores in Sydney, New South Wales, was carried out during November 1956 and of 6 "pedoscopes" in country towns in that state in June 1957. In assessing the safety of the machines, the following criteria were adopted: the useful beam must not exceed 12 r per minute; the dosage rates at the operator's position and 10 feet in front of the foot opening must not exceed 12.5 mr per hour; the weekly permissible dose of radiation for whole-body exposure must not be more than 300 mr; individual members of the occupationally exposed group should not receive more than a total accumulated dose to the reproductive cells of 50 r up to the age of thirty, and not more than 50 r additional up to the age of forty.

It was found that the beam intensity of the machines averaged 20.0 r per minute and ranged from 2.2 to 70.8 r per minute; that dosage rate (*a*) to the operator averaged 147 mr per hour and ranged from 0 to 1,100; and (*b*) at the viewing positions ranged from 0 to over 150 mr per hour; that when the machine was switched on and the foot opening was unobstructed, the average scatter radiation 10 feet in front of the machine was 32 mr per hour, but if the customer's foot was in position, the average was 16 mr per hour.

Only 4 units (11 per cent) fulfilled all the standards adopted for this survey. Fourteen of the 37 machines (37 per cent) had beam intensities less than 12 r per minute; 11 had dosages to the operator of less than 12.5 mr per hour; 11 conformed to the requirement that the dosage rate should not exceed 12.5 mr per hour at a point 10 feet in front of the foot opening. The present international dosage standard (300 mr) was not exceeded, although it was closely approached by one unit. Under existing conditions it would be possible for salespeople working fifty weeks a year for twelve years to acquire a gonadal dosage greater than 50 r from some of these machines before the age of thirty. At 2 units, only 3 and 18 exposures per week would suffice. Only 7 machines had a nearby notice informing the public that the pedoscope should be operated by authorized personnel alone. In some cases the customer was permitted to manage the unit without supervision.

The authors conclude that fluoroscopes should not be allowed in shoe stores. At least, their use should be restricted to "licensed" personnel with the status and authority to resist unnecessary customer demands, technical knowledge adequate to the safe use of the machine, and medical knowledge about foot abnormalities and diseases.

Seventeen tables.

Radiation Hazards Attending Use of Transportable Image Intensifier. Jörgen Kockum, Kurt Lidén and Olof Norman. Acta radiol. **49**: 369–376, May 1958. (University Hospital, Lund, Sweden)

The Philips image intensifier is of such a design that it may be used in departments other than those under the direct control of a radiologist. Its operating range varies from 0.3 to 3 ma and from 55 to 75 kv. The radiation exposure rate is thus comparable to that with conventional fluoroscopy if the higher kilovolt and milliampere factors are used.

With phantoms of various sizes, the authors measured the dosage rates for different physical factors in and about the primary beam with the phantom in two positions—5 cm. from the tube and at the same distance from the image intensifier.

The results indicated that the uncovered hand should never be placed in the primary beam and demonstrate the need of definite time limits for the various physical factors. The time of use of the machine could be lengthened by using the lowest kilovoltage and milli-

amperage at which visualization is adequate. The use of lead rubber aprons and gloves, together with overall control of exposure time, makes the radiation hazard to the operator acceptably small.

The study also covered radiation leakage from the tube, indicating that revised standards of the International Commission on Radiologic Protection should be considered for transportable apparatus of this nature. The possibility of disturbance of alignment of the primary beam and intensifier during transportation should also be carefully checked.

Two figures.

J. A. GUNN, M.D.
Grand Rapids, Mich.

Some Unusual Observations on Radiation Injury to Bone. J. Kolář and R. Vrabec. Fortschr. a. d. Geb. d. Röntgenstrahlen **88:** 571–573, May 1958. (In German) (Radiologische Klinik der Karls-Universität, Prague 2, Czechoslovakia)

The authors briefly report 3 out of a collection of 110 cases of radiation damage to adult bone. One patient had been treated with 5,250 r to each heel for "nondescript" pain. In the second case fluoroscopic observation for one hour in an attempt at removal of a needle from the thenar soft tissues resulted in radiation damage. The third case was treated with an unknown amount of radiation for an eczema of the lower leg. All patients showed signs of severe post-irradiation changes: sclerosis, loss of architecture and defects in the involved bones, with pathological fractures.

It is interesting to note that 52 of the 110 patients were treated for benign conditions. This corresponds to the statistics of medical liability insurance companies.

Four roentgenograms.

G. A. DOEHNER, M.D.
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Effects of Irradiation of the Fetus. Ten-year Follow-up of Pelvimetry During Pregnancy. Stephen D. Mills, Andre J. Bruwer, Edward A. Banner, George D. Davis, and Robert P. Gage. Minnesota Med. **41:** 339–341, May 1958. (Mayo Clinic, Rochester, Minn.)

Following a brief review of recently reported radiation effects and hazards, the authors turn to their own experience with infants of 226 mothers who received x-ray pelvimetry during pregnancy. One hundred fifty-five of the irradiated infants have been followed for ten years and an additional 35 infants for varying periods of less than ten years. No instances of leukemia or other malignant disease developed in any instance. The dose of radiation delivered at the depth of the fetus by the pelvimetric technic employed in the ten-year group was calculated to be 3.5 r.

The death rate from malignant disease of all types for children less then fifteen years of age in the United States for 1952 was approximately 10 per 100,000 population. Consequently it is admitted that the small sample here is of questionable statistical significance. Even though the sample is small, however, it offers no evidence to support the suspicion of increased leukemia or other malignant disease in infants whose mothers received diagnostic x-ray procedures (pelvimetry) during gestation. In the authors' opinion "the advantages of x-ray pelvimetry to the obstetrician would seem to justify the very limited risk of potential injury to the fetus."

One table.

JAMES W. BARBER, M.D.
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A Simple Method for Reducing the Radiation Hazard Associated with Photofluorography. Howard L. Goldman and Henry H. Shultz. Am. Rev. Tuberc. **77:** 923–930, June 1958. (New York State Department of Health, Albany, N. Y.)

The authors used a Masonite phantom to determine the effectiveness of several protective devices in reducing radiation to the gonadal area, as well as the entrance and exit skin doses, in chest radiography. They found that a combination of a lead diaphragm at the tube to confine the primary beam to the desired area, local shielding of the lower half of the body by lead rubber, and the addition of 2 mm. of aluminum filtration of the x-ray beam reduced the male gonadal dose from 170 to 20 milliroentgens for a total of fifty exposures and the entrance skin dose from 45.2 to 24.0 roentgens for fifty exposures. The lead diaphragm and aluminum filter were fitted to the machine. The lead rubber shield was hinged and extended from the level of the lower aspect of the cassette nearly to the floor. The device is shown in photographs.

Four photographs; 1 diagram; 1 table.

JOHN H. JUHL, M.D.
University of Wisconsin

EXPERIMENTAL STUDIES

Further Evidence of Indirect Induction by X-radiation of Lymphocytic Neoplasms in Mice. L. W. Law and Michael Potter. J. Nat. Cancer Inst. **20:** 489–493, March 1958. (Leukemia Studies Section, National Cancer Institute, Bethesda, Md.)

Total thymectomy has been shown to reduce the incidence of spontaneous, carcinogen-induced, and x-ray-induced lymphocytic neoplasms of the thymus in mice and to increase the mean age at death. Thymectomy does not influence certain high leukemic strains where the lymphocytic neoplasm arises at extra-thymic sites.

The introduction of an autologous or isologous non-irradiated thymic graft in thymectomized mice following irradiation restored the potentiality of the host to develop lymphocytic neoplasms in the thymus. To differentiate between neoplasms arising from thymic cells not previously irradiated and those arising from thymic tissue repopulated by host cells, thymic tissue which was compatible but genetically different was used.

Subcutaneous implants from donors one to ten days of age were made in the right axillary region at fourteen, twenty-one and twenty-eight days after the last of four weekly exposures to x-rays. In the present study 9 neoplasms have arisen to date from thymic grafts transplanted to 113 thymectomized irradiated mice. Two neoplasms appeared as early as three months after grafting. Thymic tissue grafted into thymectomized, but nonirradiated mice has not in a single instance given rise to a lymphocytic neoplasm in fifty mice under observation for seventeen months.

A post-irradiation influence persisting at least twenty-eight days is postulated.

One table.

W. J. VARLEY, M.D.
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Changes in the Central Nervous System After 700 r Total-Body X-Irradiation. W. O. Caster, E. S. Redgate, and W. D. Armstrong. Radiation Res. **8:** 92–97, January 1958. (Laboratory of Neurophysiology, University of Minnesota, Minneapolis 14, Minn.)

Chemical and electrocorticographic studies were

undertaken to investigate the possibility that the brain may contain a small population of highly radiosensitive cells. Subsequent to 700 r total-body irradiation physiological and chemical changes were found in the central nervous system of the rat. At three to twelve hours after irradiation there were significant decreases in brain DNA and in both high- and low-frequency activity in the electrocorticogram. Within the next two to three days all these values returned to or exceeded normal levels, and there were changes in the concentrations of water and electrolyte in the brain. In the four- to ten-day period both brain DNA and the low-frequency activity in the electrocorticogram were below control levels. Except for a rise at ten days, the high-frequency activity was normal throughout this period.

In general, the low-frequency electrocorticographic activity paralleled changes in brain DNA. Increases in high-frequency activity occurred at times coinciding with the acute and LD 50 death periods.

The Effect of Single Irradiation by X-rays on the Developing Brain in Rats. E. N. Kosmarskaya and Yu. I. Bareshnew. Med. radiol. **3:** 23–31, March-April 1958. (In Russian)

The effect of x-rays on the development of the brain of white rats in the early postnatal period (from birth to fourteen days) was studied. This period was chosen because active processes of growth and multiplication of cells and capillaries and formation of various portions of the brain take place in rats during the first fourteen to seventeen days.

Irradiation of 250–500 r to the cerebral hemispheres caused disturbance in their growth manifested by decrease in size, especially of the medial portion of the occipital lobe. The injurious effect of x-rays is especially pronounced in the cerebellum. However, there is no disturbance in the growth of the corpora quadrigemina. The earlier the irradiation, the greater is the injurious effect on brain development.

B. ABRAMSON, M.D., AND F. RIEBEL, M.D.
Columbus, Ohio

The Effect of Total X-ray Irradiation on the Secretory Function of the Stomach and Intestines. M. F. Nesterin. Med. radiol. **3:** 61–66, March-April 1958. (In Russian)

The secretory function of the stomach and intestines following total-body irradiation in the dose of 200 r was studied. Experiments were performed on dogs with Pavlov's pouch and isolated sections of intestines.

Following irradiation the quantity of gastric juice was increased. This condition of hypersecretion lasted from twelve to fourteen days. In analysis of the secretory curve in dogs with Pavlov's pouch a disturbed relationship of the phases of stomach secretion was noted (following irradiation the relative amount of the juice secreted during the nervous phase was decreased, while that secreted during the chemical phase increased). The periodic character of the secretion of the intestinal juice was not changed following irradiation, though the amount was increased in certain dogs. The value of enterokinase and basic phosphatase was increased two- to threefold. This change lasted for about two weeks. Fecal excretion of enterokinase and phosphatase was also increased the first few days after irradiation.

B. ABRAMSON, M.D., AND F. RIEBEL, M.D.
Columbus, Ohio

Intestinal Weight Loss in Mice Irradiated by Roentgen Rays, Gamma Rays, and Fast Neutrons. M. A. Patetta-Queirolo, M. L. Randolph, and J. A. Sproul, Jr. Acta radiol. **49:** 393–400, May 1958. (Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tenn.)

It has been observed in the past that mice die earlier after lethal doses of neutrons than with comparable doses of roentgen or gamma rays. It has been postulated that this effect is due to a relatively high biological effectiveness of neutrons for intestinal injury.

The present experiment was conducted to further test that possibility. Female mice were irradiated under controlled conditions with roentgen, gamma, or neutron irradiation in dose ranges of 50 to 700 rad. The irradiated mice and controls from all groups were sacrificed at varying periods of time up to eight days and the cleansed small intestine was weighed. It was found that the weight of the small intestine decreased during the first forty-eight hours after irradiation as a linear function of the dosage applied. There was no particular difference between x-, gamma and neutron irradiation after one day, but at two days the relative biological effectiveness was found to increase with the linear energy transfer, being 1.0, 1.5, and 2.0 for the gamma rays, roentgen rays, and neutrons respectively. This result is in keeping with the hypothesis that the earlier mortality of mice exposed to neutrons results from relatively greater injury to the intestinal tract than is produced by gamma or roentgen rays.

Three tables.

J. A. GUNN, M.D.
Grand Rapids, Mich.

Experimental Hydronephrosis Produced by Beta Irradiation of the Ureter. Lucien B. Guze and William O'Shea. J. Urol. **79:** 801–806, May 1958. (W. O'S., Yale University School of Medicine, New Haven, Conn.)

Beta irradiation from a strontium applicator was delivered by the authors to the exposed ureters of a series of rats in order to produce a gradual and sustained obstruction. In a control series the same operative procedure was used but no irradiation was applied. All animals were followed by serial pyelography after surgery.

Mechanical compression of the exposed ureter in 8 control animals for one minute (to approximate the pressure of the applicator in the experimental series) resulted in moderate hydronephrosis of a week duration. Approximately equivalent changes were seen following a radiation dose of 300 rep. A dose of 700 rep produced hydronephrosis which was maximum at one week, persisting to the fourth week, declining until the seventh or eighth, and then secondarily increasing to the twelfth week. In the series given 1,500 rep the hydronephrosis was sustained until the twelfth week before any decline was seen.

One roentgenogram; 1 photomicrograph; 2 graphs.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Functional Studies of the Calf Adrenal Cortex Following Total-Body Exposure to a Single Lethal Dose of γ-Radiation. George Rosenfeld. Am. J. Physiol. **192:** 232–240, February 1958. (Physiology Division, Naval Medical Research Institute, Bethesda, Md.)

The influence of a lethal dose of whole-body gamma-radiation from a cobalt-60 source (600 r) on adrenocortical function was investigated by removing the adrenals

of irradiated calves at various intervals after exposure and perfusing the exposed and control glands with an oxygenated artificial medium containing either steroid substrates or ACTH. The functional capacity derived from the ACTH studies was evaluated in three ways: (1) maximum two-hour corticoid output, (2) maximum output/gm. adrenal tissue, and (3) maximum output/kg. body weight. Within twenty-four hours after exposure, the irradiated glands revealed increases in these indices of 64, 48 and 71 per cent, respectively. Following this initial rise, their biosynthetic capacity declined to normal levels by about the fourth day before increasing again preterminally. A marked terminal depletion occurred prior to death, as evidenced by a mean decrease of 49 per cent in the maximum output per gram tissue of the exposed glands.

The absence of an abnormal biogenetic pattern in response to maximal corticotrophic stimulation (ACTH studies) and of a differential depletion in any of the specific biosynthetic enzymatic systems examined (steroid substrate studies) demonstrated that adrenocortical dysgenesis did not occur despite the development of generalized sepsis, toxemia, hemorrhage, anemia and the other severe disturbances associated with radiation sickness death.

Five tables.

Fractionated Dose Effects on Survival and Organ Weights in X-Irradiated Mice. J. G. Kereiakes, W. H. Parr, and A. T. Krebs. Am. J. Physiol. **191:** 131–134, October 1957. (U. S. Army Medical Research Laboratory, Fort Knox, Ky.)

The authors present their observations on the mortality of animals exposed to fractionated doses of irradiation and the intestinal and spleen weight changes. Two hundred and eighty mice were divided into seven groups. The mice in Group 1 served as controls. Those in Group 2 were given a 700-r single dose of total-body x-irradiation. Groups 3 through 7 were also given 700 r, but the dose was delivered in five equal fractions of 140 r, with intervals between fractions of one, three, five, seven, and nine hours, respectively. The 700-r single dose was 100 per cent lethal. A one-hour interval between each of the five 140-r doses was sufficient to give 15 per cent survival. The maximum survival, 55 per cent, was found for Group 5 (five-hour interval). Further increase of the interval to seven and to nine hours resulted in a survival of 45 per cent and 40 per cent, respectively.

The pattern of the intestinal dry weight response was similar to that for survival. Fractionating the total dose did not seem to alter significantly the 700-r single dose spleen wet weight value. The findings suggest that the fast recovery of the mitotic process and of the nucleic acid metabolism in the small intestine at about five hours after irradiation with doses between 100 r and 200 r may be responsible for the observed results for the five-hour interval.

Effect of X-Irradiation on the Function of Adrenal Autotransplants in the Rat. Leland C. Wyman, Rae Whitney, Ralph F. Goldman, Patricia L. Griffin, and Donald I. Patt. Am. J. Physiol. **192:** 51–57, January 1958. (Department of Biology, Boston University, Boston, Mass.)

In experiments carried out by the authors, adrenalectomized rats having intramuscular autotransplants of adrenocortical tissue regenerated from adrenal glands x-irradiated with 2,000 r *in vitro* immediately prior to implantation did not gain weight as rapidly and had a higher mortality than control rats with nonirradiated transplants. Moreover, at fourteen days after operation they were more susceptible to histamine poisoning, water intoxication, and exposure to cold, exhibiting little or no advantage over adrenalectomized rats in withstanding the first two stresses. The impairment in function was correlated with reduction in mass of secreting adrenocortical tissue, and presumably decrease in circulating level of corticosteroids, resulting from delayed regeneration of the x-irradiated transplants.

Rats with intramuscular transplants regenerated in sites locally irradiated with 2,000 r just before transplantation of the glands withstood histamine poisoning at fourteen days after operation as well as controls.

Rats with subcutaneous transplants in the ears irradiated with 2,000 r at twenty-eight days after operation (established transplants) and tested two weeks later responded to exposure to cold like their controls.

Six tables.

Effects of Roentgen Irradiation on the Tumor Bed. III. The Different Inhibiting Action on the Growth of Mouse Mammary Carcinoma Resulting from Pre- or Posttransplantation Irradiation. H. Vermund, K. W. Stenstrom, D. G. Mosser, and M. K. Loken. Radiation Res. **8:** 22–31, January 1958. (University of Minnesota Medical School, Minneapolis 14, Minn.)

The authors report an extension of previous experiments on the effects of roentgen irradiation on the tumor bed (Radiation Res. **2:** 180, 1955; **5:** 354, 1956. Abst. in Radiology **66:** 486, 1956; **69:** 320, 1957) to include a comparison between the effects of irradiation delivered (1) to the tumor bed before the injection of a nonirradiated tumor cell suspension and (2) to the leg after it had been injected with the same tumor either before or after the tumor transplant had become palpable. Male mice of the Z (C_3H) strain, six to twelve weeks of age, were used for transplantation of the mammary carcinoma originating spontaneously in females of the same strain.

The tumors were found to be very radioresistant when irradiated more than three weeks after the transplantation. By contrast, tumor growth could be completely suppressed or greatly delayed if the tumor area was irradiated within two weeks after the transplantation. The latent period, during which the tumor cells lay dormant, lasted for many months or even exceeded one year if the irradiation was given a short time after the transplantation.

Pretransplantation irradiation of the tumor bed did not prevent tumor growth completely but did retard tumor development and prolonged the average survival of the animals.

Tumor cells transferred by serial transplantation over many generations appeared more resistant to immediate posttransplantation irradiation than tumor cells transferred only a few times.

An attempt is made to interpret the experimental data in terms of (1) the influence of the recipient host on the radiosensitivity of transplanted tumors, (2) a possible difference in the radiosensitivity of the tumor cells at different intervals after the transplantation, or (3) simply a result of better oxygenation of the tumor cells within the first two weeks after transplantation.

One graph; 5 tables.

Genetic Factors Influencing Irradiation Protection by Bone Marrow. II. The Histocompatibility-2 (H-2) Locus. Delta E. Uphoff, and L. W. Law. J. Nat. Cancer Inst. **20**: 617–624, March 1958. (National Cancer Institute, Bethesda, Md.)

Further evidence is introduced to show that an immune response of graft against host is responsible for the secondary phase of the irradiation syndrome.

Inoculation of homologous or heterologous bone marrow has been shown to protect mice against lethal total body x-irradiation during the first thirty-day post-irradiation period. Inbred mice treated with homologous tissue following irradiation have an initial recovery period, but this is followed by a greatly reduced longevity compared to animals treated with isologous bone marrow. It has been found that in treating certain hybrids, the hybrid marrow affords better protection than marrow of either parental strain.

Since susceptibility and resistance to tissue transplantation in the mouse are determined by "histocompatibility genes," one such gene, governing resistance and susceptibility to tumor transplantation, designated the histocompatibility-2 (H-2) locus, was studied for its effect in the successful prevention of mortality following a lethal dose of x-irradiation.

In gathering data, a standard inbred strain in which isogenic resistant lines arose by a single gene mutation at the H-2 locus was used, with coisogenic lines and hybrids. At three to four months of age the mice were exposed to approximately a 30-day LD 95 radiation dose for these coisogenic lines. Three groups were run concurrently; the irradiated control (non-inoculated), the irradiated group receiving isologous marrow, and a group receiving coisogenic or hybrid marrow.

Isologous and hybrid bone marrow was shown to protect mice receiving lethal x-radiation, but early signs of severe diarrhea, emaciation, and a dermatitis appeared following the use of coisologous bone marrow. In hybrids between the coisogenic strains, parental bone marrow caused signs of the secondary irradiation syndrome, while hybrid marrow gave excellent protection.

The data are in accord with expectations of a graft against host reaction, wherein the host contains antigens absent from the grafted marrow and the graft has the ability to react against these foreign antigens.

Four tables. W. J. VARLEY, M.D.
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Relative Effects of Splenic and Bone-Marrow Cells on Lethally Irradiated Mice. Takashi Makinodan, Nazareth Gengozian, and Isabel C. Shekarchi. J. Nat. Cancer Inst. **20**: 591–600, March 1958. (Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tenn.)

It has been established that radiation death of lethally irradiated mice can be prevented by treatment with foreign bone marrow. However, many mice subsequently die from a delayed foreign bone-marrow reaction. Two hypotheses have been formulated to explain this reaction: (1) Lethal irradiation has caused a temporary curtailment of the immune mechanism of the host. As the host antibody-producing cells recover, they will react against the proliferating foreign transplant. (2) The antibody-producing cells present in the transplanted bone-marrow tissue react against the host tissues and thereby cause the delayed reaction.

In an attempt to solve this problem, the authors studied the relative effects of spleen (an accepted site of antibody production) and bone-marrow cells on the immune mechanism and survival patterns of lethally irradiated mice.

All animals received 950 r total-body irradiation followed after four hours by intraperitoneal injection of 1 ml. of 1 per cent rat red blood cells. Some also received normal isologous spleen cells, and others bone-marrow nucleated cells, intravenously. Circulating antibodies were detected in the sera of mice receiving isologous spleen five days after treatment, reaching a peak on the twelfth day, but none were discovered following bone-marrow injections. Both preparations were effective against radiation death: over 95 per cent of the treated animals survived. With homologous spleen and marrow cells quite different results were obtained. Thirty-nine per cent of a group receiving homologous bone marrow died within the first thirty days, while 98 per cent of those given homologous spleen cells died. In this latter group, earlier deaths were recorded when the dose of spleen cells was larger.

Two figures; 1 table. J. A. BURWELL, M. D.
Mercy Hospital, Pittsburgh

Preclusion of Secondary Phase of Irradiation Syndrome by Inoculation of Fetal Hematopoietic Tissue Following Lethal Total-Body X Irradiation. Delta E. Uphoff. J. Nat. Cancer Inst. **20**: 625–632, March 1958. (National Cancer Institute, Bethesda, Md.)

Lethally irradiated mice will survive acute irradiation damage when they are given a post-irradiation inoculation of bone marrow or spleen. A lasting recovery is produced by isologous bone marrow, but inoculation of homologous bone marrow results in death during a secondary phase of the irradiation syndrome. The secondary phase of the irradiation syndrome is presumably due to a delayed foreign bone-marrow reaction. Two main theories have been postulated to explain this reaction: (1) a delayed immunological response of the host to the foreign tissue; (2) an immune response of the marrow graft against the irradiated host (graft-*versus*-host reaction).

In this study, the author attempts to show that fetal hematopoietic tissue does not initiate a graft-*versus*-host reaction, owing to its lack of immunological maturity ("immunological non-reactivity"). No reaction was observed following inoculation of fetal tissue under experimental conditions that would elicit a lethal reaction if adult tissue (bone marrow) were used.

The data presented are in agreement with the graft-*versus*-host reaction theory as an explanation of the secondary phase of the irradiation syndrome.

One figure; 4 tables. J. A. BURWELL, M.D.
Mercy Hospital, Pittsburgh.

Increased Survival in Irradiated Animals Treated with Bacterial Endotoxins. Willie W. Smith, Ilo M. Alderman, and Ruth E. Gillespie. Am. J. Physiol. **191**: 124–130, October 1957. (Radiation Branch, National Cancer Institute, Bethesda, Md.)

A single injection of endotoxin derived from Gram-negative bacteria brought about an increased survival in lethally irradiated animals when administered immediately after or twenty-four hours before exposure. A Van de Graaff generator operating at 2.5 MEV, 0.6 ma, on a gold transmission target, was used for irradiation. The half-value layer was 1 cm. lead, target

distance 1 m, and dose rate 250–300 r/min. Inherent filtration consisted of 3 mm. stainless steel and 13 mm. of water, to which was added a brass field flattener of 12 mm. thickness. Mice responded better to the injection before irradiation and hamsters to the injection after irradiation. The effect was associated with a reduction in infection, very pronounced in the case of α-streptococcus of *Proteus* and still significant in the case of *Pseudomonas* infection. No beneficial effect was obtained when mice were given three endotoxin injections during one week or six injections during two weeks prior to irradiation. The beneficial effect was not necessarily associated with the granulocytosis which begins within a few hours after the endotoxin injection, or with the conditions under which nonirradiated animals show an increased resistance to bacterial challenge.

Three graphs; 6 tables.

Resistance to Experimental Infection and Mobilization of Granulocytes in Irradiated Mice Treated with Bacterial Endotoxin. Willie W. Smith, Ilo M. Alderman, and Ruth E. Gillespie. Am. J. Physiol. **192:** 263–267, February 1958. (National Cancer Institute, Bethesda, Md.)

In an extension of earlier studies the authors investigated the ability of mice to respond to an intraperitoneal injection of *Salmonella typhosa* endotoxin with increased resistance to experimental *Pseudomonas* infection. Observations were made over a period of three weeks following just sublethal irradiation, with and without lead shielding of the hind legs. In most experiments the radiation dose was 700 r of 2.5 MEV, 0.6 ma x-rays, h.v.l. 1 cm. of lead, from a Van de Graaff generator. This was an approximate LD 10 in twenty-eight days (LD 50, 810 r). In the shielding experiments the dose was 500 r of 200 kvp, 20 ma x-rays, also essentially sublethal. In general, the increase in resistance to infection paralleled the ability to mobilize granulocytes. No increase in resistance was observed three days after irradiation in the unshielded mice, while in the shielded mice the increase was only slightly less than in nonirradiated mice. In nonirradiated mice given a series of endotoxin injections, increased resistance to the infection persisted in the absence of a granulocytic response. This effect could be abolished by an intervening exposure to sublethal radiation. An intraperitoneal injection of zymosan, which has been reported to increase survival of irradiated mice under certain conditions, also increased resistance to the infection without producing a granulocytosis. The rapidly developing resistance to infection following an endotoxin injection was transitory and apparently is not responsible for the recently reported increase in survival of lethally irradiated mice (see preceding abstract).

Three illustrations; 1 table.

The Effect of Irradiation of the Body on the Virulence of Typhoid Fever Bacilli. G. A. Chekatilo. Med. radiol. **3:** 37–41, March-April 1958. (In Russian)

A study was made of the pathogenic properties of typhoid fever bacilli from irradiated (by 100, 200, and 300 r) guinea-pigs. The animals were infected intracutaneously after irradiation. The pathogenic properties of the organisms isolated from the cutaneous foci were examined by intraperitoneal inoculation of white mice with 15 and 30 million microbes. The total of 156 strains were examined and 762 mice were infected.

It was established that the mortality of mice infected with the bacterial cultures isolated from irradiated guinea-pigs was higher than in mice infected with cultures isolated from nonirradiated control mice (54.5 per cent in the experimental group, as against 38 per cent in the control group). The longer the microbes remained in the tissues of the host the greater became their virulence. This property was more pronounced in irradiated animals.

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On Absorption of Dysentery Endotoxins in Radiation Sickness of Rabbits. M. A. Tumanian and F. M. Sosnovskaya. Med. radiol. **3:** 46–48, March-April 1958. (In Russian).

It was demonstrated by the authors' earlier work with labeled atoms that dysentery endotoxins are absorbed from the intestines into the blood stream when introduced into rabbits *per os*. They are revealed in the blood within half an hour after administration. When rabbits were irradiated by LD 50 doses, the intensity of absorption of the dysentery endotoxin was changed. It increased during the first twenty-four hours after irradiation and then normalized for a short time, after which it was replaced by a stable increase of absorption which began at the end of the first week and continued for three to four weeks after irradiation.

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Relative Effectiveness of Neutrons for Production of Delayed Biological Effects. I. Effect of Single Doses of Thermal Neutrons on Life Span of Mice. John B. Storer and Phyllis C. Sanders. Radiation Res. **8:** 64–70, January 1958. (Los Alamos Scientific Laboratory, Los Alamos, N. Mex.)

White Swiss mice were exposed to single, graded doses of x-rays or thermal column radiation (thermal neutrons plus gamma rays) and allowed to live their life span. Mean life span was calculated for each group, and per cent life shortening as a function of dose was determined. Under the conditions of the authors' experiment, life shortening amounted to about 5 per cent per 100 rads for either type of radiation. The relative biological effectiveness (RBE) of thermal column radiation for shortening life span was 1.00 ± 0.24, a value not significantly different from the RBE for the production of thirty-day death.

One graph; 2 tables.

Relative Biological Effectiveness of Neutrons for Production of Delayed Biological Effects. II. Effect of Single Doses of Neutrons from an Atomic Weapon on Life Span of Mice. John B. Storer, B. S. Rogers, I. U. Boone, and P. S. Harris. Radiation Res. **8:** 71–76, January 1958. (Los Alamos Scientific Laboratory, Los Alamos, N. Mex.)

Mice were exposed to neutrons or to mixtures of neutrons and gamma-rays from an atomic detonation and allowed to live out their life span. It was found that neutrons shortened the mean life span by 6.7 per cent per 100 rads, and it was estimated that gamma-rays shortened the life span by 2.6 per cent per 100 rads. The relative effectiveness for production of this delayed response was 2.6, a value in close agreement with those previously obtained for production of acute effects.

One graph; 1 table.

On the Mechanism of Radiation Effect on DNA Synthesis. L. G. Lajtha, R. Oliver, T. Kumatori, and F. Ellis. Radiation Res. **8:** 1–16, January 1958. (Radiobiology Laboratory, Department of Radiotherapy, Oxford, England)

The authors define DNA synthesis as the process during which formate C^{14} is incorporated into DNA (deoxyribonucleic acid). In a previous publication (Brit. J. Cancer **8:** 367, 1954), they reported investigations of the cell cycle and the effects of large doses of x-rays (5,000 rads) on the synthesis of DNA in human bone marrow cells *in vitro*. They now describe a study of the mechanism by which inhibition of DNA synthesis by x-rays is produced.

The technic for culturing cell suspensions of human bone marrow *in vitro* and for high-resolution autoradiography on smear preparations from such cultures was the same as that used in earlier experiments (J. Clin. Path. **5:** 67, 1952). The radiation employed was in the range of 140 to 300 kv, with dose rates to the cells of 250 to 400 rads/min. Grain counts were performed on stained autoradiographs.

Large doses (>500 rads) of x-radiation were found to inhibit directly the process of DNA synthesis in human bone marrow cells *in vitro*. Small doses (< 300 rads) did not inhibit DNA synthesis in cells which already had started the process. In cells, however, which were in the presynthetic period at the time of radiation, such small doses produced a 40 to 50 per cent depression of the number of cells entering the synthetic period in a given time, without affecting the rate of subsequent DNA synthesis. It is suggested that, unless two populations are involved, the damage suffered by the presynthetic cells results in a half-speed progress through the presynthetic period. It appears that in the cells there is a system connected with but not identical with DNA synthesis (?trigger mechanism, ?specific) which is more radiosensitive than the process of DNA synthesis.

The authors state that in studies of radiation effects on DNA synthesis a clear differentiation has to be made between effects on the process of DNA synthesis (synthetic period) and those of the presynthetic period, since different mechanisms may be affected.

Three illustrations; 9 tables.

The Effect of Intravenous Introduction of Novocain on the Course of Radiation Sickness. S. P. Sizenko and V. V. Markevich. Med. radiol. **3:** 72–76, March-April 1958 (In Russian)

Preliminary intravenous introduction of Novocaine solution in animals (0.08 to 0.1 c.c. per kilogram of body weight) decreases the effect of x-ray and gamma-ray irradiation (LD 50). It is manifested by a less severe course of the radiation sickness, an increased number of surviving animals, a prolongation of life, and a less pronounced reduction in weight.

Introduction of the Novocaine solution following irradiation has no therapeutic effect on the course of radiation sickness and in certain cases even aggravates it.

Leukopenia is less marked in animals with preliminary Novocaine administration as compared to control animals.

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